A revised Chapter 5 is being submitted based on the number of changes required by the deficiency list and shifting of text to different pages due to these changes. This Chapter 5 submittal replaces the previous submittal in Volume 3. The following colored pages describe the edits that have been made along with the deficiency if the change directly addresses one. As in other sections, the Division's deficiency is in *italics* and the ACD responses are in regular font.

The following is a listing of the deficiencies for Chapter 5 followed by text describing how each deficiency is addressed:

***R645-301-121.200**, The Applicant cannot use "Not Applicable" to state how they met the requirements of the Utah Coal Rules. The Applicant must state that features like previously mined area and man-made features are not present rather than those items are "Not Applicable".*

Everywhere in Chapter 5 that used "Not Applicable" to state how the regulations were met has been changed to either a statement explaining why the each regulation does not apply or appropriate information is provided to address the regulation. The sections that have been updated with these changes include: 513.100, 513.300, 513.400, 514.200-250, 521.110, 521.121, 521.122, 521.124, 521.169, 528, 533, 553.220 and 553.700.

***R645-301-121.200**, The Applicant was not consistent with the description of the road surface. In Section 534.100-200, the Applicant stated that eighteen inches of crushed rock or gravel would be used for road surfacing. On Drawing 23, the Applicant does not list eighteen inches of road surface and states that gravel will be placed as needed.*

Drawing 5-23 is updated to be consistent with the description provided in 534.100-200.

R645-301-521, *The Applicant must change the term project area to permit boundary on each map in submittal. The term project area is not defined in Section R645.100 of the Utah Coal Rules while the term permit boundary is. •The Applicant must also include all areas under control of the Applicant such as access routes to Kane County Road 136, and any portion of roads that the Applicant has exclusive control over (access route around Alton).*

All drawings that show the permit boundary are resubmitted with the legend modified to change the description to either *"permit area"* or *"permit boundary"*. The drawings that show the boundary with the permit area hatched are changed to *"permit area"*. The drawings that have the boundary without hatching are changed to "*permit boundary"*.

The following drawings are resubmitted with the modifications described above:

Chapter 1: Drawings 1-1 through 1-4
Chapter 2: Drawing 2-2
Chapter 3: Drawings 3-1 through 3-6
Chapter 5: Drawings 5-1, 5-2, 5-3, 5-9, 5-10, 5-13 through 5-23, 5-25, 5-26, 5-27, 5-33 through 5-39
Chapter 6: Drawings 6-1, 6-2, 6-5, 6-9
AVF Report: Plate 3 and 4
Chapter 7: Drawings 7-1, 7-2, 7-3, 7-10, 7-12

All these drawings are provided in the appropriate sections within this submittal.

<u>Other Areas Under Control of Alton Coal Development, LLC</u>

Alton Coal Development has land leased from C. Burton Pugh located outside the Permit Area. These lands are identified on Drawing 1-3 and Alton Coal Development's interest is declared on page 1-6, Chapter 1, Volume 1.

At this time, there are no other areas outside the permit area under the exclusive control of Alton Coal Development. Plans to access Kane County Road 136 (CR 136) have been modified on all drawings to show access at the point that CR 136 crosses the permit boundary. The section of road from this point (permit boundary), north to the road relocation point will remain under the jurisdiction of Kane County and will be maintained by the County as a public road. For details related to this road status, refer to Appendix

1-7; the Kane County Road K3900 (136) Closure, Relocation and Replacement Agreement, Miscellaneous Provision C, Page 7

R645-301-521.120*, The Applicant must show on Drawing 1-1 the specific type of buildings and structures that are in or near the permit boundary. The buildings shown on Drawing 1-1 are from a USGS topographic map and the description is generic. The Division needs to know the type of buildings within 1,000 feet of the permit boundary because other regulations direct what actions must be taken based on the type of building.*

Drawings 1-5 and 1-6 have been added in Chapter 1, Volume 1. These drawings show all buildings that are within 1,000 feet of the proposed permit area along with a description. The buildings on Drawing 1-5 show the Swapp Ranch. The buildings on Drawing 1-6 show the Sorenson Ranch.

R645-301-521.130 through R645-301-521.132 and R645-301-521.141*, The Applicant must address plans to build a public road that will bypass the town of Alton to facilitate mining. The Division has received comments from Alton residents that the town officials have been in negotiations with the Applicant to build a bypass road. The purpose of the bypass road is to route coal truck traffic around Alton. Road construction solely for the purpose of facilitating coal mining is considered "affected area" as defined by R645-100-200 and must be shown on mine maps.*

All practical routes for bypassing the town of Alton with the coal truck traffic are across privately owned lands. Negotiations that are occurring are between private landowners and Alton Coal Development, LLC (ACD). At this time, no formal agreements have been reached with any landowners; therefore ACD has no plans to provide the Division regarding a bypass around Alton. Should an agreement be reached in the future, ACD will notify the Division and provide appropriate plans at that time.

R645-301-521.132*, The Applicant must update all permit area boundaries to show that the access road from the close section of County Road 136 to the mine site will be within the permit area.*

The section of road from the permit boundary, north to the road relocation point will remain under the jurisdiction of Kane County and will be maintained by the County as a public road. For details related to this road status, refer to Appendix 1-7; the Kane County Road K3900 (136) Closure, Relocation and Replacement Agreement, Miscellaneous Provision C, Page

7. Since this section of road will continue to be a public road under the jurisdiction of Kane County it is not included as part of the permit area in this application. All drawings showing the closure point of this road and access to the facilities area are modified to be consistent with this agreement.

R645-301-521.141*, The Applicant must show on Map 5-10 or a similar map the anticipated dates for when the Applicant would mine coal from the expansion areas. The Division needs to know the dates when the Applicant anticipates acquiring additional subareas because the preferred reclamation plan is based on additions to the permit area.*

As discussed in the meeting between ACD and the Division on September 2, there are too many unknown variables (FEIS ROD, lease sale, permit approval, etc…) to provide dates for mining expansion areas. As agreed to in the meeting, ACD is providing a time frame for final reclamation of the area should there be a significant delay in acquiring approval to mine expansion areas. The commitment provided is that ACD will proceed to the alternative reclamation scenario within two years from the time that the permit area is mined and operations cease. This commitment is made in section 521.141, third paragraph of the section.

R645-301-521.150*, The Applicant states that for much of the permit area the accuracy of the original contour map was 5 feet. The Applicant then interpolated the information to construct 2-foot contours. The Division cannot rely upon contours that the Applicant interpolated. The Applicant must provide the Division with maps and cross sections based on the original topographic maps.*

As requested by the Division in the meeting on September 2, drawings showing contours generated from flight data have been revised to 5 foot contours. The following drawings have been revised from 2' contours to 5' contours: 5-1, 5-20, 5-20A, 5-21, 5-21A, 5-22, 5-35, 5-36, 5-37, 5-37A. Also, text explaining the reason for the interpolation of the 2' contours has been removed from Section 521.150.

R645-301-521.190, *The Applicant must state in the PAP the legal description of the permit area and include the number of federal, state and fee acres. The Division suggests the information be in table format and be located in Chapter 1 of the PAP. Even if there are no federal or State acreages the table is requested.*

The legal description of the permit area and a table showing the number of acres by ownership is provided in Chapter 1, Volume 1 with revisions located on pages 1-3, 1-4 and 1-5.

R645-301-523, R645-301-524, R645-301-524.200 and R645-301-121.200, *Section 523 states that blasting may be implemented after clearing vegetation. Section 524 suggests that a "cursory analysis" indicates blasting may not be necessary for this mining operation due to the soft clay and shale overburden and due to the mining of the coal from on top of the seam to avoid a wet clay layer below. However, submittal of a blasting plan is required with the permit application in accordance with R645-301-524. Please provide a blasting plan or alternatively, provide more supporting information, such that the Division might provide approval of the plan without blasting, under R645-301-524.220. ie. seismic testing of rock, hardness of coal, etc.*

A blasting plan is provided as Appendix 5-4. Text changes were made in the following areas to address the addition of this plan:

- Section 524: A commitment is made to provide the Division with a blast design prior to commencing blasting operations since what geologic conditions may require blasting are not known at this time.
- Section 524.200: Header for section 524.200 is added and text referring to items required in the blasting plan is replaced with a reference to the blasting plan in Appendix 5-4.

R645-301-524.300, *The Applicant must remove from Section 524.300 – 350 of the PAP the comments about supplying the Division with a blasting plan if five pounds or more of explosives or blasting agent is used. The exclusion applies only to underground mines. The Applicant must supply the Division with a pre-blast survey for any blasting, as part of their blasting plan.*

Text referring to the exclusion for blasts less than 5 pounds explosives has been replaced with language committing to conducting a pre-blast survey prior to commencing blasting operations.

R645-301-526.116, *The application must state whether Alton Coal Resources, LLC. or Kane County will take charge of the County Road 136 re-alignment and subsequent reclamation. • Details of the public road 136 re-alignment must included as an appendix to the application and include* *the use of cattle guards and fencing in the design (requested during informal conference comment period) and describe measures for protection of the public during construction. •The reclamation plan narratives and maps must be revised to describe construction of the road in its approximate original alignment.*

- Text in Section 526.116 has been revised to clarify that Kane County will take charge of County Road 136 re-alignment and subsequent reclamation. Agreements related to this status are located in Appendix 1-7.

- The Environmental Assessment (EA) for the road relocation provided in Appendix 1-7 addresses installment of cattle guards and gates at maintained fence lines on page 25 and in the Stipulations section of the FONSI. Construction of the road will be required to meet the stipulations in the FONSI.

- Reclamation plan narratives and maps have been revised to include reconstruction of County Road 136 (K3900) to the approximate original location. The alignment of this road is revised to route the road around the fill above approximate original contour in the Preferred Reclamation scenario. A Grant of Easement by the private landowner (C. Burton Pugh) for this revised road alignment is provided in Appendix 1-7. This easement was requested by Kane County and the easement is assigned to the County and has been recorded. The narrative in Section 542 under the bullet removal of roads is revised. This section is also revised to include which roads will remain postmining. Drawings that show the details for the County Road reconstruction within the permit area are 5-22E, 5-22F, 5-22G, 5-35 and 5-37.

R645-301-526.220, *The application must describe the equipment required for lighting the 24 hour operation and the effect on the night sky as seen from Bryce Canyon National Park and the Dixie National Forest. [PB]• The Applicant must list and show on appropriate maps all minor facilities at the site such as gates, power lines, water lines and sewage lines. In addition, the Applicant should remove the description of the surface facilities and from Section 521.180 and place then in Section 526.*

- As agreed to in the meeting between the Division and ACD on September 2, Section 526.220 is revised to provide a list of anticipated lighting equipment that would likely be used to illuminate the night mining operations.
- Minor facilities have been added to Drawings 5-3, 5-4, 5-5, 5-6, 5-8A, 5-8B, and 5-8C. All these drawings have been revised or added to show the minor facilities. A description of the minor facilities is provided in Section 526.220 under the new bullet added named **Minor Facilities**. In addition, the facilities description has been removed from Section 521.180. Text in 521.180 is added to reference the description in 526.220 and the specific Drawings are listed that contain the information required by 521.180.

R645-301-526.222 and R645-301-423, *The Applicant must give a detailed description of the specific dust control structures that will be installed to ensure fugitive dust is controlled.*

A description of the water system that will be used for dust control is added in Section 526.220 under the bullet **Dust Control Structures**. This system will provide a source of water to load the water truck which will spray active roads and working areas to control dust as needed. Additional details for this system are provided on Drawing 5-8C.

R645-301-527.100, *The Applicant must state specifically which roads will be classified as primary roads and which roads will be classified as ancillary. The Division will not accept a blanket statement that all future roads will be ancillary. In addition, some roads that are not used to haul coal or spoil might be primary roads. In addition, the Applicant must also classify the road that connects the site with Kane County Road 136.*

Text detailing primary roads has been added to Section 527.100. Seven individual roads are classified as primary roads in this section and drawings 5-22A through 5-22G have been added to provide additional details for primary roads that were not provided in previous submittals. Also, Drawings 5-35 and 5-37 are revised to show the postmining roads along with the postmining topography. The blanket statement about all future roads being ancillary roads has been removed. The section of Kane County Road 136 that connects to the mine site is classified as a public road, on public land under the jurisdiction of Kane County.

R645-301-527.220, *The Applicant should modify the comment in Section 527.200 of the PAP that "As currently planned, no natural drainage ways will be altered or relocated due to road construction," to acknowledge that were will be a permanent diversion in Lower Robinson Creek to allow for maximum economic recovery, but not to facilitate road construction.*

Text is added to 527.220 to clarify that Lower Robinson Creek is being temporarily diverted for purposes of maximizing coal recovery and not for road construction purposes.

R645-301-535.140, *In Section 528.310 and 535.100, the Applicant states that spoil will be placed in lift not to exceed four feet in thickness and meet a 90% compaction based on the standard Procter tests. The Applicant needs to provide the Division with the specifications of the equipment that will be doing the compaction. The Division is unaware of any equipment that can compact lifts up to four feet thick and achieve a 90% Proctor.*

The revised geotechnical analysis provided in Appendix 5-1 is submitted based on the revised design of the spoil. The revised design of the excess spoil and fill above approximate original contour provides concave slopes that grade from 5h:1v to 4h:1v to 3h:1v, bottom to top. This change in the slope design has allowed for lowering the compaction specification of the spoil to 85%. This specification will be met by the method of construction and the equipment used. Large haul trucks (100 to 240 ton) will dump the dirt in place on each lift and a dozer(s) will spread the spoil into four foot lifts. The spreading process will require tracking over the spoil lift repeatedly with the dozer (D10 to D11 size). In addition, most of the spoil lift will also be repeatedly traveled over by the large haul trucks in order to place the material on each lift. The pressure exerted on the four foot lifts from the large mining equipment will provide sufficient compaction to meet the 85% specification. Text in Sections 528.310 and 535.100 has been revised to reflect the revised 85% compaction specification.

R645-301-542.200, *The Applicant must include cross sections that show how the site will be reclaimed in the event that the federal leases are not acquired.*

Drawing 5-37A has been added to provide cross sections of the Alternate Scenario for reclamation. This is the scenario that addresses reclamation of the site in the case that the federal leases are not acquired by ACD.

R645-301-542.320, *The Applicant must either list in the PAP or show on a reclamation map those facilities that will remain after final reclamation or state specifically in the PAP that all facilities will be removed at final reclamation.*

Drawings 5-35 and 5-37 shows plan view locations of the facilities and roads that will remain after final reclamation. Details for these facilities can be viewed on Drawings 5-8C, and 5-22A through 5-22G.

Also, text has been added to Section 542 listing these facilities. These changes are located under the bullets **Removal of Structures** and **Removal of Roads**.

R645-301-542.600, *Maps and narrative in the application must describe reconstruction of County Road 136 to its original alignment as requested by the County. In addition, Applicant must state who will reconstruct those sections of Kane County Road 136 that will be closed to the public, along with a timetable for reclamation • The Applicant must specifically state which roads will be retained along with the supporting documentation. The Division cannot accept blanket statements about how roads not needed for the postmining land use will be left.*

- Details for the reconstruction of County Road 136 are provided on Drawings 5-35, 5-37, 5-22E, 5-22F and 5-22G. The alignment of this road is revised to route the road around the fill above approximate original contour in the Preferred Reclamation scenario. A Grant of Easement by the private landowner (C. Burton Pugh) for this revised road alignment is provided in Appendix 1-7. This easement was requested by Kane County and the easement is assigned to the County and has been recorded. A narrative describing this reconstruction is included in Section 542 under the bullet **Removal of Roads**. This narrative includes the approximate time frame for reconstruction. Drawing 5-38 shows the expected time frame for reclamation based on the operation year (from the time operations begin).
- All roads that will remain following reclamation are listed in Section 542 under the bullet **Removal of Roads**. These postmining roads are provided on Drawings 5-35, 5-37 and 5-22C through 5-22G. The blanket statement about how roads not needed for post mining land use will be left has been revised in this section to clarify that all roads

not classified in this application as postmining roads will be reclaimed.

***R645-301-553 and 542.200**, The Applicant will describe how and where the overburden will be placed for the initial box cut. • The Applicant must have a specific timetable for completing rough backfilling and grading in the PAP. • The Applicant must provide surveys of coal recovery at the end of each calendar month and show coal recovery on a plan view of the mining area at the end of each calendar month. • The Applicant must provide detailed descriptions of how overburden will be placed and provide documented data on a monthly basis of placed backfill volumes. • The Applicant must provided rough backfill volumes taken from the survey of contemporaneous cross sections showing toe of backfilled slope on latitudinal and longitudinal baskis in relationship to the coal seam being mined. • The Applicant must establish and follow a ground control plan for the safe control of all highwalls, pits and spoil banks, as approved by MSHA under 30 CRF77.1000 and the MSHA approved plan will be included as part of the mining and reclamation plan. • The Applicant has requested a variance from the 180 day requirement for contemporaneous backfilling and grading of the southern pit (69 acres in Phase 3), based upon the continued use of the area as a haul road. While reclaiming the road may not be practical, reclaiming areas away from the road might be feasible. The application should describe a time table for the requested variance and limit the acreage of variance to that needed for the road.*

- Overburden from Pit 2 (the boxcut) is placed in the excess spoil structure located west of Pit 1. The design for this structure is shown in Drawing 5-17 as the excess spoil pile. Since the detailed description of overburden removal is Section 553, text has been added to this section to clarify where this overburden is placed and Drawing 5-17 also has an arrow added with text clarifying that spoil from Pit 2 (the boxcut) is in the excess spoil pile.
- As specified in R645-301-553, rough backfilling and grading will follow coal removal by not more than 60 days or 1500 linear feet except in the case of the requested exemption in the south end of the permit area (Pits 24 through 30) and is described in Section 553 and detailed on Drawing 5-19. Text is revised in Section 553 to

clarify this commitment and to further explain the need for the exemption.

- Alton Coal Development, LLC will provide the Division, as part of the annual report for each calendar year, a plan view outline of the coal recovery, a 5' interval contour map of backfill progress and a reclamation progress map. This information will be submitted by June 30th of each calendar year. This text has been added to the end of Section 553 for lack of finding any regulations that directly apply to providing this information.
- Section 553 provides a detailed description of how overburden (spoil) will be placed at the Coal Hollow Mine and includes backfill verse spoil balance data for the operation.
- Alton Coal Development, LLC will obtain an MSHA approved Ground Control plan prior to commencing mining operations.
- The request for an exemption from rough backfilling and grading within 60 days or 1500 linear feet is not requested because of a road as specified by the Division's analysis. This exemption is also not requested as variance from contemporaneous reclamation but is a request that the Division allow the rough backfilling and grading in the southern mining area (Pits 24 through 30) to follow behind mining operation of the pits by approximately 2,000 feet instead of 1,500 feet as specified in the regulation. This request is made based on a spoil verse pit backfill balance deficiency that occurs as a result of the high strip ratios in the central part of the mining area (Pits 10 through 15). The fill above original contour is constructed because overburden from pits that are 150'+ deep (Pits 10 through 15) do not fit into pits that are 70 feet deep and less (Pits 1 through 9). Vice versa, it takes overburden from a couple pits that are only 80 feet deep (Pits 16 to 30) to fill one pit that is 150+ deep. This exemption keeps contemporaneous reclamation in process by eliminating the need for temporary spoil stockpiles that have to be rehandled and placed in pit areas at a later date, which would be created while mining the high strip ratio pits. Text has been added to Section 553 to more clearly explain this concept and the need for the exemption. Drawings 5-17 through 5-19 show the step by step process of how this overburden balance works during the mining process and provides the actual volumes and why this exemption is needed. The only other option to this exemption is that the fill above approximate original contour (the spoils pile) would be changed to a temporary spoil stockpile.

Reclamation of most the mining area would then delayed until mining is complete. Then most of the pile is rehandled (6.8 million LCY) and placed in the final pits. This will delay final reclamation of most the mining area by approximately four years and will leave no backfill area to start mining in the adjacent federal coal reserves should they be acquired. If the federal coal reserves are then acquired and mining operations approved, a new boxcut would then need to be constructed and a new excess spoil pile will be required. Recovery of federal coal along the west edge of the permit boundary in the south pits would require significant excavation of reclamation within the permit area. This plan is the Alternate Scenario provided in the application (Drawings 5-37, 5-37A). This exemption minimizes these negative impacts.

R645-301-553.110 and R645-301-553.800*, The request for variance from Approximate Original Contour must describe whether the restoration of original drainage patterns can be achieved ((R645-301-762.100) or whether the criteria of R645-301-553.800 apply to this surface mine. Excess spoil should be graded to attain the lowest practical grade (R645-301-553.800) and provide a natural appearance to the contours of the spoil pile which would include irregular slopes and irregular surface such that the reclaimed site is compatible with the natural surroundings (R645-301-412.300).*

The criteria of R645-301-553.800 (Thick Overburden) does apply to this surface mine. The overall material balance of the mining area is shown in the Alternate Scenario overburden Table provided in Section 553. This table shows that excess spoil is expected to be approximately 1.8 million yards. In addition to the excess spoil, ACD is requesting this variance based on plans to transition future mining into adjacent federal coal reserves. The need for this variance is explained in the overburden removal and backfill process which details the step by step process in the text and tables found in Section 553 in conjunction with viewing Drawings 5-10, 5-17 , 5-18, 5-19, 5-35 and 5-36. The process viewed in these documents is the mine plan for the Preferred scenario. By allowing this variance, impacts to reclaimed areas along the western edge of the permit boundary will be minimized. The excess spoil pile and the fill above approximate original contour has been redesigned to provide a natural appearance. The revised design includes concave shaped slopes that are significantly flatter than the original design to minimize erosion. Irregular slopes and shape of the pile have also been added to make it closely resemble naturally occurring hills in the general area of the operation as requested by the Division. This revised design is shown on Drawing 5-35 and cross sections on Drawing 5-36. Additional text has been added to Section 553 to more clearly explain the processes and need for this variance in the two scenarios (Preferred and Alternate) associated with the request for Variance from Approximate Original Contour. Text has been added to Section 553.110 clarifying that R645-301-553.800 (Thick Overburden) does apply to this mine. Text in Section 553.810 has been changed to reflect the revised design of the excess spoil area and fill above approximate original contour.

R645-301-553.130, *The Applicant must show that all reclaimed slopes (including those not associated with the excess spoil area) have a safety factor of 1.3 or greater and that the slope angles are less than the angle or repose. The Applicant includes safety factor calculations for the excess spoil areas but did not mention the safety factors in other areas. One way to address the issue is to identify the slopes that would have the lowest safety factors (longest slope and steepest slope) and show that they meet the minimum safety factor requirements. In addition, the Applicant must also state why the reclaimed slope angles are less than the angle of repose.*

Appendix 5-5 is added to the application to specifically address this deficiency. Reclaim slopes will not exceed 3h:1v while the expected angle of repose for spoil is approximately 1.5h:1v. Text has been added to Section 553.130 to address this regulation and the associated study by Dr. Ben Seegmiller.

R645-301-533.300, *The Applicant must state how the impoundments will be protected from rapid drawdown. Rapid drawdown can occur in earth dams when rapid reductions in the water level produce dangerous changes in pore water pressure. This occurs because the water in the soil tends to flow back into the reservoir through the upstream face. In this scenario, even a period of some weeks may bring about a 'rapid' change in the pore water pressure distribution.*

A rapid draw down analysis has been added to the revised Appendix 5-1, pages 6 through 7 in the main report. A worst case scenario rapid draw down was analyzed in this report. A rapid drawdown analysis was completed assuming the spillways are plugged, the basin fills to top of the embankments and then the water is released or pumped down to the base of basins. This scenario is very unlikely so the safety factors reported are highly conservative. Safety factors for this additional analysis resulted in a range from 1.2 to 1.9. Based on this analysis, no additional protection measures are needed for the impoundments in relation to rapid drawdown. Section 533.300 is added to the Chapter 5 text with appropriate information and references regarding this analysis.

The following is a listing of changes for Chapter 5 that do not directly address a deficiency but were necessary based on other edits, new information or updates related to the Mine and Reclamation Plan:

R645-301-521.121, Reference for new Drawing 1-6 as showing buildings within 1,000 feet of the permit area is added.

R645-301-521.122, County Road 136 and the pipeline to Pond 20-1 is added as Man-Made features within the permit area.

R645-301-521.170, Additional description of primary haul roads and the proposed conveyor system.

R645-301-526.220, Text in this section has been modified to include the latest revisions to the facilities area layout and plans. These text changes are on pages 5-3 and 5-31. Details for these revisions can be viewed on Drawings 5-3 through 5-8C.

R645-301-526.400, Description of the water system for dust control measures is provided along with a reference to appropriate drawings containing details.

R645-301-527.200, This section is updated with the latest information and designs regarding transportation facilities.

R645-301-527.220, This section is updated to include the reconstruction of Lower Robinson Creek to the approximate original alignment.

R645-301-527.220, Statement is removed which excluded pasture areas from mulching. All areas reclaimed will have mulched applied following seeding.

R645-301-532.200, Text is added that details the revised design of the excess spoil pile and the fill above approximate original contour. Also, the statement is removed which excluded pasture areas from mulching.

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CHAPTER 5

R645-301-500. ENGINEERING

510. **INTRODUCTION.**

The engineering section of the Mining and Reclamation Plan (MRP) is divided into the operation plan, reclamation plan, design criteria, and performance standards. All of the activities associated with the coal mining and reclamation operations are designed, located, constructed, maintained, and reclaimed in accordance with the operation and reclamation plan.

511. **GENERAL REQUIREMENTS**

511.100 - 511.300. <u>Contents</u>

The operation and reclamation permit application includes descriptions of the coal mining and reclamation operations with attendant Drawings, plans, and cross sections. and its potential impacts to the environment as well as methods and calculations utilized to achieve compliance with design criteria.

All this information can be viewed in this section, Drawings 5-1 through 5-39 and Appendices 5-1 through 5-5.

512. **CERTIFICATIONS**

512.100. <u>Cross Sections and Drawings.</u>

All cross sections and Drawings required under applicable portions of sections 512.100 through 512.150 have been prepared by, or under the direction of, and certified by: a qualified, registered, professional engineer; a professional geologist; or a qualified, registered, professional land surveyor, with assistance from experts in related fields such as hydrology, geology and landscape architecture.

Compliance with this section has been completed and certifications are available on all cross sections and Drawings.

512.200. <u>Plans and Engineering Designs.</u>

All plans for excess spoil, durable rock fills, coal mine waste, impoundments, primary roads and variances from approximate original contour will be certified by a qualified registered professional engineer.

Plans for excess spoil, sediment impoundments, primary roads, and a variance from approximate original contour have been certified by a qualified registered professional engineer. These certifications can be viewed on Drawings 5-22 through 5-37. No coal mine waste or durable rock fills are planned.

512.210 Excess Spoil Disposal Areas

A professional engineer experienced in the design and construction of earth and rock fills will certify the design of Excess Spoil Disposal Areas according to 535.100.

A professional engineer with experience in design and construction of earth and rock fills has certified the design of the Excess Spoil Disposal according to 535.100. An expert in the field of slope stability and geotechnical analysis has provided a thorough review of the design. This analysis can be viewed in Appendix 5-1.

512.220 - 230 Durable Rock Fills and Coal Mine Waste Structures

The MRP does not contemplate the construction of any permanent Durable Rock Fills or Coal Mine Waste structures. If such structures become part of the plan, a professional engineer experienced in the design of earth and rock fills and or disposal facilities will certify the design according to 535.100 - 536.

512.240. Impoundments.

A professional engineer experienced in the design and construction of impoundments will use current, prudent, engineering practices and will certify the design of the impoundment according to 743.

A professional engineer experienced in the design and construction of impoundments with assistance from a geotechnical expert has used current, prudent, engineering practices to design the proposed impoundments. The plans have been certified and a detailed geotechnical analysis has been provided. The certifications and drawings can be viewed in Drawings 5-25 through 5-31 and Appendices 5-1 and 5-2.

512.250. Primary Roads.

A professional engineer will certify the design and construction or reconstruction of primary roads as meeting the requirements of 742.420.

Designs of primary roads have been certified as meeting the requirements of 742.420.

512.260. Variance From Approximate Original Contour.

In areas of the MRP where a variance from the approximate original contour is required, a professional engineer will certify the design for the proposed variance from the approximate original contour, as described under 270, in conformance with professional standards established to assure the stability, drainage and configuration necessary for the intended use of the site.

A variance from the approximate original contour has been certified in conformance with professional standards to assure the stability, drainage and configuration necessary for the intended use of the site.

513. **COMPLIANCE WITH MSHA REGULATIONS AND MSHA APPROVALS.**

513.100. Coal Processing Waste Dams and Embankments

The MRP does not contemplate the construction of any coal processing waste dams and embankments.

513.200. Impoundments and Sedimentation Ponds

No impoundments or sedimentation ponds meeting the size or other qualifying criteria of MSHA, 30 CFR 77.216(a) exist or are planned within the proposed Mine Permit Area. Should impoundments and sedimentation ponds meeting the size or other qualifying criteria of MSHA, 30 CFR 77.216(a) become necessary, compliance with the requirements of MSHA, 30 CFR 77.216 will be met.

513.300. Disposal of Underground Development Waste, Coal Processing Waste and Excess Spoil in underground mine workings.

The MRP does not contemplate any underground development waste, coal processing waste, or excess spoil being disposed of in underground mine workings.

513.400. Refuse Piles

The MRP does not contemplate the construction of any refuse piles.

513.500. Capping, Sealing and Backfilling Openings to the Surface from the Underground.

Each shaft, drift, adit, tunnel, exploratory hole, entryway or other opening to the surface from the underground will be capped, sealed, backfilled or otherwise properly managed consistent with MSHA, 30 CFR 75.1711

All wells will be managed to comply with R645-301-748 and R645-301-765. Water monitoring wells will be managed on a temporary basis according to R645-301-738.

Wells constructed for monitoring groundwater conditions in the proposed Coal Hollow Mine permit and adjacent area, including exploration holes and boreholes used for water wells or monitoring wells, will be designed to prevent contamination of groundwater and surface-water resources and to protect the hydrologic balance. A diagram depicting typical monitoring well construction methods is shown in Figure 7-11. Monitoring wells will include a protective hydraulic seal immediately above the screened interval, an annular seal plugging the borehole above the hydraulic seal to near the ground surface, and a concrete surface seal extending from the top of the hydraulic seal to the ground surface which is sloped away from the well casing to prevent the entrance of surface flows into the borehole area. Well casings will protrude above the ground surface a sufficient height so as to minimize the potential for the entrance of surface water or other material into the well. A steel surface protector with a locking cover will be installed at monitoring wells to prevent access by unauthorized personnel. Where there is potential for damage to monitoring wells, the wells will be protected through the use of barricades, fences, or other protective devices. These protective devices will be periodically inspected and maintained in good operating conditions. Monitoring wells will be locked in a closed position between uses.

When no longer needed for monitoring or other use approved by the Division upon a finding of no adverse environmental or health and safety effects, or unless approved for transfer as a water well under R645-301-731.100 through R645-301-731.522 and R645-301-731.800, each well will be capped, sealed, backfilled, or otherwise properly managed, as required by the Division in accordance with R645-301-529.400, R645-301-631.100, and R645-301-748. Permanent closure measures will be designed to prevent access to the mine workings by people, livestock, fish and wildlife, machinery and to keep acid or other toxic drainage from entering ground or surface waters.

If a water well is exposed by coal mining and reclamation operations, it will be permanently closed unless otherwise managed in a manner approved by the Division.

Permanent closure and abandonment of water wells greater than 30 feet in depth will be in accordance with the requirements of "Administrative Rules for Water Well Drillers", State of Utah, Division of Water Rights or other applicable state regulations. Abandonment of wells will be performed by a licensed water well driller. The wells to be abandoned will be completely filled using neat cement grout, sand cement grout, unhydrated bentonite, or bentonite grout, or other materials approved by the Utah State Engineer's office. Alternatively, the well may be abandoned using a different procedure upon approval from the Utah State Engineer's office.

Abandonment materials will be introduced at the bottom of the well or required sealing interval and placed progressively upward to the top of the well. The casing will be severed a minimum of 2 feet below the ground surface. A minimum of 2 feet of compacted native material will be placed above the abandoned well upon completion.

Within 30 days of the completion of well abandonment procedures, a report will be submitted to the State Engineer by the responsible licensed driller giving data related to the abandonment of the well. This shall include the name of the licensed driller or other person(s) performing abandonment procedures, name of well owner at the time of abandonment, the address or location of the well by section, township, and range, abandonment materials and equipment used, water right or file number covering the well, the final disposition of the well, and the date of completion.

Exploration holes and boreholes will be backfilled, plugged, cased, capped, sealed, or otherwise managed to prevent acid or toxic contamination of water resources and to minimize disturbance to the prevailing hydrologic balance. Exploration holes and boreholes will be managed to ensure the safety of people, livestock, fish and wildlife, and machinery.

If a water well is exposed by coal mining and reclamation operations, it will be permanently closed unless otherwise managed in a manner approved by the Division.

If any exploration boreholes are to be used as monitoring wells or water wells, these will meet the provisions of R645-301-731

Boreholes will be backfilled to within 1 foot of the land surface with concrete or other materials approved by the Division as necessary to prevent contamination of groundwater or surface-water resources or to protect the prevailing hydrologic balance. The upper approximately 1 foot will be backfilled with native materials to facilitate reclamation (see Drawing 6-11). Exploration holes and boreholes that may be uncovered during mining and reclamation activities will be permanently closed unless approved for water monitoring or otherwise managed in a manner approved by the Division.

513.600. Discharges into an underground mine

The MRP does not contemplate discharges into an underground mine.

513.700. Surface Mining Closer than 500 Feet to an Active Underground Mine

The MRP does not contemplate mining within 500 feet of an active underground mine.

513.800. Coal Mine Waste Fires

The MRP does not contemplate the generation of any coal mine waste.

514. INSPECTIONS

All engineering inspections, will be conducted by a qualified registered professional engineer or other qualified professional specialist under the direction of the professional engineer.

514.100 – 140 Excess Spoil.

A professional engineer or specialist experienced in the construction of earth and rock fills will conduct inspections, provide reports certified by a registered professional engineer, and otherwise meet the requirements of R645-301-514.100 through R645-301-514.140.

514.200 - 250. Refuse Piles.

The MRP does not contemplate the construction of any refuse piles.

514.300. Impoundments.

514.310 - 313. Certified Inspection.

A professional engineer or specialist experienced in the construction of impoundments will inspect impoundments. Inspections will be made regularly during construction, upon completion of construction, and at least yearly until removal of the structure or release of the performance bond. The qualified registered professional engineer will promptly, after each inspection, provide to the Division, a certified report that the impoundment has been constructed and maintained as designed and in accordance with the approved plan and the R645 Rules. The report will include discussion of any appearances of instability, structural weakness or other hazardous conditions, depth and elevation of any impounded waters, existing storage capacity, any existing or required monitoring procedures and instrumentation and any other aspects of the structure affecting stability. A copy of the report will be retained at or near the mine site.

514.320. Inspection Standard and Frequency

The MRP does not contemplate construction of any impoundments meeting the NRCS Class B or C criteria for dams in TR-60, or the size or other criteria of 30 CFR Sec. 77.216. If such impoundments become necessary, they will be examined in accordance with 30 CFR Sec. 77.216-3. Impoundments not meeting the NRCS Class B or C Criteria for dams in TR-60, or subject to 30 CFR Sec. 77.216, will be examined at least quarterly. A qualified person designated by Alton Coal Development LLC will examine impoundments for the appearance of structural weakness and other hazardous conditions.

515. REPORTING AND EMERGENCY PROCEDURES

515.100. Slides

Any time a slide occurs which may have a potential adverse effect on public, property, health, safety, or the environment, Alton Coal Development LLC will notify the Division by the fastest available means and comply with any remedial measures required by the Division.

515.200. Impoundment Hazards.

If any examination or inspection of an impoundment discloses that a potential hazard exists, the person who examined the impoundment will promptly inform the Division of the finding and of the emergency procedures formulated for public protection and remedial action. If adequate procedures cannot be formulated or implemented, the Division will be notified immediately.

515.300. <u>Temporary Cessation</u>

515.312.

During a temporary cessation, surface facilities in areas in which there are no current operations, but in which operations are to be resumed under an approved permit will be effectively secured.

515.320.

Before temporary cessation of coal mining and reclamation operations for a period of 30 days or more, or as soon as it is known that a temporary cessation will extend beyond 30 days, a notice of intention to cease or abandon operations will be submitted to the division. This notice will include:

- A statement of the exact number of acres which have been affected in the permit area prior to such temporary cessation,
- The extent and kind of reclamation of those areas which has been accomplished, and
- Identification of the backfilling, regrading, revegetation, environmental monitoring, and water treatment activities that will continue during the temporary cessation.

516. PREVENTION OF SLIDES

The moderate topography in the area of the planned Coal Hollow Mine will minimize the potential for unplanned slides. A natural barrier will, however, be left undisturbed except as necessary for roads, sedimentation control, temporary topsoil and spoil storage and similar features, beginning at the elevation of the coal seam and extending from the outslope for a distance of at least 50 ft. The barrier will be retained in place to prevent slides and erosion.

520. OPERATION PLAN.

521. GENERAL.

The proposed Coal Hollow Mine is located approximately 2.5 miles south of Alton, Utah. In order to maximize the use and conservation of the coal resource, coal will be recovered using large hydraulic excavators or front end loaders and off-road trucks. Mined coal will be hauled to a central coal area for crushing and placement into a stockpile. Coal from the stockpile will be transferred into a bin and loaded into over the road trucks for transport.

The plan, with Drawings, cross sections, narrative, descriptions, and calculations indicates how the relevant requirements will be met. The lands subject to coal mining and reclamation operations over the estimated life of the operations are identified and briefly described. All appropriate information is located in the subsequent sections and

Drawings 5-1 through 5-39 and Appendices 5-1 through 5-5. Topsoil piles and removal sequencing is shown on Drawing 2-2.

521.100. Cross Sections and Drawings.

The application includes cross sections, Drawings and plans showing all the relevant information required by the Division. Appropriate information is provided in Drawings and cross sections 5-1 through 5-39.

521.110. Previously Mined Areas.

Historically, there has been some underground mining of coal within the Alton Amphitheater. The following underground mines are known to have historically existed within the Amphitheater:

- Seaman Mine
- Smirl Mine
- Alton Mine
- Johnson Mine
- Silver Mine

There are not any known mines that existed or currently exist within the permit area or the adjacent area as defined in R645-100-200. There is also not any active coal mining operations in the area.

521.120. Existing Surface and Subsurface Facilities and Features.

521.121. Buildings

The location of all buildings in and within 1,000 feet of the proposed permit area, with identification of the current use of the buildings is shown on Drawings 1-5 and 1-6.

521.122. Surface and Subsurface Man-Made Features

The only known surface and subsurface manmade features that exist within the permit area are:

- County Road 136 (location shown on Drawing 5-3)
- Water pipeline to Pond 20-1 (location shown on Drawing 7-7)

521.123. Public Roads

One public road, Kane County Road 136 is located in or within 100 feet of the proposed permit area and is shown on Drawing 5-3.

521.124. Existing areas of spoil, waste, coal development waste, and noncoal waste disposal, dams, embankments, other impoundments, and water treatment and air pollution control facilities.

There is one impoundment currently located within the permit area which is Pond 20-1 shown on Drawing 7-7. The area of this impoundment is approximately 3,400 square feet.

There no other areas of existing spoils, waste, coal development waste, and noncoal waste disposal, dams, embankments, other impoundments, and water treatment and air pollution control facilities within the permit area.

521.125. Ponds and Other Impoundments

The MRP does not contemplate construction of any permanent water impoundments; coal processing waste banks and coal processing waste dams or embankments. The planned location of each sedimentation pond is shown on Drawing 5-3.

521.130. Landowners and Right of Entry and Public Interest Drawings.

All boundaries of lands and the names of present owners of record of both surface and subsurface within the Mine Permit Area are shown on Drawing 1-3 (Surface) and Drawing 1-4 (Subsurface).

521.132. Permit Boundary

The boundaries of land within the proposed permit area are shown on all applicable Drawings.

521.133. Public Roads

No mining or reclamation operations are planned within 100 ft. of a public road. However mine vehicles may cross the right-of-way of Kane County Road #136 for a short period early in the operation's life. Appropriate measures, including signage and mine operating practices and training will be implemented to protect the public.

521.133.2 Relocating a Public Road:

The design of any relocated road will be approved by Kane County authorities, or such other authorities as have jurisdiction. Appropriate measures will be taken to prevent entrance into the mining area via the pre-existing road, and appropriate signage and barriers will be installed to protect the public.

521.140. <u>Mine Drawings and Permit Area Drawings</u>.

521.141 The boundaries of all areas proposed to be affected over the estimated total life of the coal mining and reclamation operations, with a description of size, sequence and timing of the mining, the coal mining and reclamation operations to be conducted, the lands to be affected throughout the operation, and changes in facilities or features to be caused by the proposed operations;

These items are depicted on Drawings 5-1 through 5-38.

Two options are provided for final reclamation of the permit area. The Preferred option is shown on Drawings 5-35 and 5-36. The anticipated time schedule for this option is shown on Drawing 5-38. This option includes mining operations transitioning into the adjacent federal coal reserves. In the case that these reserves are not acquired by ACD, an alternative plan is provided in Drawing 5-37 and 5-37A which requires rehandling much of the fill above original contour to fill in the final pits. If a circumstance occurs where mining of the permit area is complete but approvals have not been acquired to continue mining in the federal coal reserves; within two years of ceasing operations ACD will then proceed to reclaiming the final pits as specified in the alternative plan.

521.143 The proposed disposal sites for placing excess spoil generated at surface areas affected by surface operations and facilities for the purposes COAL MINING and RECLAMATION ACTIVITIES according to:

- *R645-301-211: The applicant will present a description of the premining soil resources as specified under R645-301-221. Topsoil and subsoil to be saved under R645-301-232 will be separately removed and segregated from other material.*

  The soil resources for the proposed excess spoil disposal area are described in Appendix 2-1. A plan has been developed for removal of topsoil and suitable subsoil based on the soil descriptions in this appendix. The handling plan can be viewed on Drawing 2-2. Topsoil and acceptable subsoil will be separately removed and segregated from other material prior to placement of any spoil.

- *R645-301-212: After removal, topsoil will be immediately redistributed in accordance with R645-301-242, stockpiled pending redistribution under R645-301-234, or if demonstrated that an alternative procedure will provide equal or more protection for the topsoil, the Division may, on a case-by case basis, approve an alternative;*

  Excess spoil will have topsoil and subsoil redistributed in an approximately uniform, stable thickness with the approved post mining land use, contours and surface water drainage systems. Material handling practices will prevent excess compaction of these materials. Handling practices will also protect the materials from wind and water erosion before and after seeding and planting.

- *R645-301-412.300: Criteria for Alternative Postmining Land Uses.*

  The MRP does not contemplate alternative postmining land uses.

- *R645-301-512.210: Excess Spoil. The professional engineer experienced in the design of earth and rock fills will certify the design according to R645-301-535.100.*

  A professional engineer experienced in the design of earth and rock fills with assistance from a geotechnical expert has certified the design according to R645-301-535.100. These certifications can be viewed on Drawings 5-35, 5-36 and 5-17 through 5-19.

- *R645-301-512.220: Durable Rock Fills*

  No durable rock fills are planned.

- *R645-301-514.100: Excess Spoil. The professional engineer or specialist will be experienced in the construction of earth and rock fills and will periodically inspect the fill during construction. Regular inspections will also be conducted during placement and compaction of fill materials.*

  A professional engineer or specialist that is experienced in the construction of earth and rock fills will inspect the fill during construction and regular inspections will also be conducted during placement and compaction of fill materials.

- *R645-301-528.310: Excess spoil will be placed in designated disposal areas within the permit area, in a controllable manner to ensure mass stability and prevent mass movement during and after construction. Excess spoil will meet the design criteria of R645-301-535. For the purposes of SURFACE COAL MINING AND RECLAMATION ACTIVITIES, the permit application must include a description of the proposed disposal site and the design of the spoil disposal structures according to R645-301-211, R645-301-212, R645-301-412.300, R645-301-512.210, R645-528.310, R645-301-535.100 through R645-301-535.130, R645-301-535.300 through R645-301-535.500, R645-536.300, R645-301-542.720, R645-301-553.240, R645-301-745.100, R645-301-745.100, R645-301-745.300, and R645-301-745.400.*

  Excess spoil will be placed in the area designated on Drawing 5-3 and 5-35. This fill will be placed in lifts not to exceed 4 feet. The material will be transported from the overburden removal area to the fill by end dump haul trucks and a dozer(s) will spread the spoil to this lift thickness. The fill will meet at minimum 85% compaction as related to the standard Procter. Final slopes will be regraded to a maximum slope of 3h:1v. The top of the fill will be sloped to approximately 2% to prevent pooling of water and to reestablish drainage similar to original flow patterns. The excess spoil placed on the non-mined areas is approximately 32 acres and varies in height from 35 to 110 feet. The area of excess fill over mined out areas (variance from approximate original contour) is an extension of the fill placed on the non-mined area and is approximately 55 acres. Combined acreage of the excess fill placed on mined and non-mined areas is 87 acres and varies in height from 60 to 100 feet above original contour. Total excess fill is 8.6 million yards. Design of this fill can be viewed in Drawings 5-35 through 5-36 and the geotechnical study can be viewed in Appendix 5-1.

- *R645-301-535.100 through R645-301-130: Disposal of Excess Spoil*

  A geotechnical analysis of the excess spoil structure design has been completed by an expert in this field. The long term static safety factor for this structure design is estimated at 1.6 to 1.7. Lifts will be placed in thicknesses not to exceed 4 feet. The lifts will meet 85% compaction by the standard Procter. The fill will be graded to allow for drainage similar to original patterns and to prevent excessive infiltration of water. Fill will be covered with subsoil and topsoil as specified in Chapter 2 to provide conditions suitable for revegetation of the area. The geotechnical study can be viewed in Appendix 5-1.

- *R645-301-535.300 through R645-301-535.500: Disposal of Excess - Spoil Durable Rock Fills.*

  No durable rock fills are planned.

- *R645-301-536.300: Disposal of Coal Mine Waste in Excess Spoil*

  No coal mine waste is planned in the excess spoil area.

- *R645-301-542.720: Excess spoil will be placed in designated disposal areas within the permit area, in a controlled manner to ensure that the final fill is suitable for reclamation and revegetation compatible with the natural surroundings and the approved postmining land use. Excess spoil that is combustible will be adequately covered with noncombustible material to prevent sustained combustion. The reclamation of excess spoil will comply with the design criteria under R645-301-553.240.*

  The excess spoil as shown in Drawing 5-35 and 5-36 will be suitable to the surrounding area and for the postmining land use of primarily grazing. No combustible excess spoil will be placed in the proposed structure. The reclamation of the spoil does not include any terraces and the slopes will not exceed 3h:1v.

- *R645-301-553.240: The final fill configuration of the fill (excess spoil) will be suitable for the approved postmining land use. Terraces may be constructed on the outslope of the fill if required for stability, control of erosion, to conserve soil* *moisture, or to facilitate the approved postmining land use. The grade of the outslope between terrace benches will not be steeper than 2h:1v (50 percent).*

The excess spoil as shown in Drawings 5-35 and 5-36 will be suitable to the surrounding area and for the postmining land use of primarily grazing. The reclamation of the spoil does not include any terraces and the slopes will not exceed 3h:1v. The long term static safety factor for these slopes is estimated to be 1.6 to 1.7.

- *R645-301-745.100: General Requirements.*

745.110: Excess Spoil will be placed in designated disposal areas within the permit area, in a controlled manner to:

745.111: Minimize the adverse effects of leaching and surface water runoff from the fill on surface and underground water;

Reclamation of the excess spoil will include topsoil and a subsoil layer. Infiltration through the reclamation is expected to be minimal based on the high clay content of these soils. In addition, laboratory data for the overburden shows that there is minimal potential for leaching of pollutants should infiltration rates become higher than expected.

The foundation of the excess spoil area also has high clay content with minimal potential for infiltration. This will provide an additional, natural barrier to protect ground water present beneath the proposed structure.

745.112: Ensure permanent impoundments are not located on the completed fill. Small depressions may be allowed by the Division if they are needed to retain moisture or minimize erosion, create and enhance wildlife habitat or assist revegetation, and if they are not incompatible with the stability of the fill; and

Permanent impoundments are not planned on the excess spoil area. Small depressions may be constructed as allowed by the Division to retain moisture, minimize erosion, create and enhance wildlife habitat or assist revegetation.

745.113: Adequately cover or treat the excess spoil that is acid- and toxic forming with nonacid nontoxic material to control the impact on the surface and ground water in accordance with R645-301-731.300 and to minimize adverse effects on plant growth and approved postmining land use.

Laboratory data representative of the overburden planned for disposal in the excess spoil area does not show acid- and toxic forming characteristics.

745.120: Drainage Control. If the disposal area contains springs, natural or manmade water courses, or wet weather seeps, the fill design will include *diversions and underdrains as necessary to control erosion, prevent water infiltration into the fill and ensure stability.*

A spring and seep survey available in Chapter 7 has identified no springs or wet weather seeps in the proposed excess spoil area. The final surface will be regraded to a contour that will route water from snowmelt and rainfall around the excess spoil as shown on the final contours Drawing 5-35. There are no manmade water courses present in the excess spoil area. No underdrains are planned for the excess spoil structure.

745.121: Diversions will comply with the requirements of R645-301-742.300

No diversions are planned in the excess spoil area.

745.122 : Underdrains

No underdrains are planned in the excess spoil area.

745.300: Durable Rock Fills

No durable rock fills are planned in the excess spoil area.

745.400: Preexisting Benches

Excess spoil will not be disposed of through placement on preexisting benches.

521.150. Land Surface Configuration Drawings.

Surface contours representing the existing land surface configuration of the proposed permit area are shown on Drawing 5-1 and the post mining land configuration is shown on 5-35. Cross sections with both these landforms are shown on Drawing 5-36.

521.160. Maps and Cross sections of the Proposed Features for the Proposed Permit Area. These maps and cross sections will clearly show:

521.161 Buildings, utility corridors, and facilities to be used:

These items are shown on Drawings 5-3 through 5-8C.

521.162 The area of land to be affected within the proposed permit area, according to the sequence of mining and reclamation:

A yearly and overall disturbance sequence for the permit area is provided on Drawing 5-2.

521.163 Each area of land for which a performance bond or other equivalent guarantee will be posted under R645-301-512;

The area of land that will have a performance bond posted is shown on Drawing 5-3.

521.164 Each coal storage, cleaning and loading area. The map will be prepared and certified according to R645-301-512;

These facilities can be viewed on Drawings 5-3 through 5-5.

521.165 Each topsoil, spoil, coal preparation waste, underground development waste, and noncoal waste storage area. The maps will be prepared and certified according to R645-301-512;

Topsoil storage areas and handling can be viewed on Drawing 2-2. Spoil placement and the excess spoil structure can be viewed on Drawings 5-3, 5-17, 5-18, 5-19, 5-35 and 5-36.

521.166 Each source of waste and each waste disposal area relating to coal processing or pollution control;

Only sizing of the coal is proposed. This process will not produce any waste.

521.167 Each explosive storage and handling facility;

Need for these facilities are not anticipated at this time. Should these facilities become necessary, appropriate drawings will be provided to the Division.

521.168 For the purposes of SURFACE COAL MINING AND RECLAMATION ACTIVITIES, each air pollution collection and control facility; and

There are no specific air pollution collection or control facilities proposed.

521.169 Each proposed coal processing waste bank, dam or embankment. The map will be prepared and certified according to R645-301-512.

The MRP does not contemplate processing of coal that will produce waste.

521.170. <u>Transportation Facilities Drawings</u>.

Transportation facilities for the Coal Hollow Mine include seven primary roads, a conveyor system, and miscellaneous ancillary/temporary roads. Numerous drawings detail the designs and specifications for each one of the proposed facilities. The following is a description of each facility and a reference for the associated drawings:

- Roads: Two primary mine haul roads are planned within the permit area. The first road extends from the coal unloading area to the first series of pits along the west side of the property. This road will be utilized for access to pits 1 through 15 (pits shown on Drawing 5-10). This road will be approximately 2,600 feet in length and will be utilized mainly during the first two years of mining. There will be three culverts installed along this road all sized for a 100 year, 24 hour storm event. The first culvert will be across a tributary of Lower Robinson Creek and will be a 36 inch corrugated steel pipe. The second culvert is the main crossing over Lower Robinson Creek and is a 96 inch corrugated steel pipe. Both of these culverts have been sized based on analysis of the Lower Robinson Creek watershed. This analysis can be viewed in Appendix A5-3. The third culvert is crossing over a diversion ditch that will route water mainly from disturbed areas along the south side of Lower Robinson Creek to a sediment impoundment. This culvert will be a 24 inch corrugated steel pipe.

  The second road extends from an intersection with the first road, located just south of the Lower Robinson Creek crossing, and proceeds south to approximately pit 25. This road is approximately 2,500 feet in length and will be used for the south pits 16 through 30. There is one culvert crossing along this road to cross a diversion ditch. This culvert will be a 24 inch culvert sized for maximum anticipated flows in the diversion.

  The following specifications apply to these Primary mine haul roads:
  1) Roads will be approximately 80' in width
  2) Approximately a 2% crown
  3) Approximately one foot deep cut ditches along shoulders for controlling storm water
  4) 18" of crushed rock or gravel for road surfacing
  5) Cut and fill slopes of 1.5 h:1v
  6) Minimum fill over each culvert will be 2 times diameter of culvert
  7) Berms placed as necessary along fills

  The ancillary roads will have similar specifications except surfacing will occur only as needed and may be narrowed to a 40 foot road width. A typical cross section for the ancillary roads can be viewed on Drawing 5-24.

  The location and details for Primary Mine Haul roads can be viewed on Drawings 5-3 and 5-22 and 5-23.

  In addition to the two roads primary Mine Haul roads, the road located within the facilities area is also classified as a primary road. This road is planned to be 24 feet wide with 24 inches of compacted sub base and 8 inches of compacted 1 inch minus gravel as surfacing. This road is referred to as "Facilities Roadway" and more details are described in 527.200 along with Drawings 5-22A and 5-22B.

In addition to the primary roads that will be present during active mining, four additional roads are planned to exist postmining and are also classified as primary roads for this reason.

Roads that will remain postmining are the following:

- Road to Water Well with details shown on Drawing 5-22D
- Road to east C. Burton Pugh property with details shown on Drawing 5-22C
- County Road 136 (K3900) with details on Drawing 5-22E, 5-22F and 5-22G. This County road will be reconstructed within the permit area by Kane County. This reconstruction will occur concurrently with the final stage of reclamation as scheduled on Drawing 5-38 and is expected to be completed by the end of Year 4.
- Road to Swapp Ranch (same specification as the Water Well Road)

The location of these roads is shown on Drawings 5-35 and 5-37 along with the post mining topography.

The ramps, benches and equipment travel paths within the active surface mining area are temporary in nature and will be relocated frequently as mining progresses. These temporary travelways are considered part of the pit due to their short term use, and are not individually designed nor engineered. They will be built and maintained to facilitate safe and efficient mine and reclamation operations.

- Conveyors: A conveyor system will be used to stockpile coal and to load highway approved haul trucks for transportation to market. The first conveyor is mainly a stacker system for the coal stockpile which will be located at the coal unloading area and will be approximately 451' in length. This conveyor is estimated to be a 48" solid frame system.

  The second conveyor is a coal reclaim belt that will be loaded by an above ground reclaim feeder from the coal stockpile and will convey coal to the loadout chute which will load the highway approved coal haulage trucks. This section will be approximately 290' in length. Similar to the first section, this conveyor is estimated to be a 48" solid frame system.

  Drawings of this system can be viewed on Drawings 5-3 through 5-5.

521.180. <u>Support facilities.</u>

Description of the support facilities is provided in Section 526.220. Drawings 5-3, 5-4, 5-5, 5-6, 5-7, 5-8, 5-8A, 5-8B, and 5-8C provide the maps, appropriate cross sections, design drawings and specifications to demonstrate compliance with R645-301-526.220 through R645-301-526.222 for each facility.

521.200. Signs and Markers Specifications.

Signs and markers will be posted, maintained, and removed by Alton Coal Development LLC. Signs and markers will be a uniform design that can be easily seen and read; made of durable material; conform to local laws and regulations, and be maintained during all activities to which they pertain;

521.240. Mine and Permit Identification Signs.

Identification signs showing the name, business address, and telephone number of Alton Coal Development LLC and the identification number of the permanent program permit authorizing coal mining and reclamation operations will be displayed at each point of access to the permit area from public roads, and will be retained and maintained until after the release of all bonds for the permit area;

521.250. Perimeter Markers.

The perimeter of a permit area will be clearly marked before the beginning of surface mining activities;

521.260. Buffer Zone Markers.

Buffer zones will be marked along their boundaries as required under 731.600

521.270. Topsoil Markers.

Markers will be erected to mark where topsoil or other vegetation - supporting material is physically segregated and stockpiled.

522. **COAL RECOVERY.**

The MRP is designed to maximize recovery of the coal resource within technological, safety and legal limitations. Coal will be recovered from the Smirl Seam which ranges in thickness from 13.5 to 18.5 feet averaging approximately 16 feet in the planned mining area. The Smirl Seam is the only surface mineable seam in the permit area. Isopach maps of the coal thickness and strip ratio can be viewed on Drawings 5-13 and 5-14

Some coal along the boundaries of the mine area will not be recovered in conjunction with the proposed operation. This includes coal underlying the pit highwalls and areas where drainage or sedimentation control structures (diversions, ditches, ponds, etc) are located. The mine is designed to minimize such losses by locating haulage ramps in the spoil rather than on the pit wall, by oversteepening the coal face at the pit edges, and by minimizing the use of out of pit ancillary roads. Coal which is left in place in these areas may be recovered in the future when adjacent property rights are secured. Current plans are for a planned maximum mining depth of approximately 200 ft. and a strip ratio of 10:1; however, the ultimate mining depth will depend on cost related factors.

A detailed mine plan has been developed for the proposed permit area and the following table along with Drawing 5-9 summarize the coal extraction for the permit area:

Description	Extraction Status	Average Coal Thickness (ft)	Average Strip Ratio* (yd^3/Ton)	Quantity (**Ton)
Total Coal within Permit Boundary	N/A	16.3	7.7	9,159,000
High Strip Ratio Area (NE corner of permit area)	Not Mined	16.5	13.5	2,764,000
Coal under highwalls and sedimentation structures	Not Mined	17.2	4.8	1,207,000
Coal under Robinson Creek Diversion	Not Mined	15.5	3.9	172,000
Recoverable Coal	Mined	16.3	6.4	5,016,000

*All strip ratios are bank cubic yards of overburden to tons of coal
**All coal tons are based on a 95% recovery factor

The application of highly flexible, open pit truck/shovel techniques will minimize losses of coal due to pit geometry or spoil support requirements, allowing the maximum possible exposure of the coal resource. The full seam section will be loaded primarily using large hydraulic backhoes. The backhoes, which can work from the top of the seam, provide the ability to efficiently and cleanly excavate the lower part of the coal seam without disturbing the pit floor. This, along with the machine's high degree of bucket horizon control will minimize floor losses. The backhoes can also work safely from the top of the seam to oversteepen the loading face along the pit walls, thus recovering the maximum amount of coal.

Where pit geometry or operational factors preclude the use of backhoes for loading, a large rubber tire front end loader will be used. These machines provide similar horizon control, can operate on the floor of the pit or on an intermediate bench, and can recover coal from confined areas such as the ends of the pits.

Rear dump haul trucks, loaded by the backhoes or front end loader, will be used to move the coal from the pit via inpit roads and the primary haulroad to the crusher and stockpile. The trucks will be equipped with "combo" beds suitable for hauling both coal and overburden, and configured to minimize coal spillage.

A net recovery of 95% (including the effects of in-pit coal losses and out-of-seam dilution) of the coal exposed in the pit is anticipated. Normal coal losses are expected due to cleaning of the top of the seam, loading losses at the seam floor, and coal oxidation near the outcrop.

No coal washing is contemplated at this time, thus there will be no coal processing losses.

Maps and cross sections providing detailed information related to coal recovery activities can be viewed on Drawings 5-9 through 5-14.

523. **MINING METHOD(s).**

The Coal Hollow Mine will be a surface coal mining operation using open pit mining methods to produce up to 2 million tons of coal per year. Primary mining equipment will include hydraulic excavators and end-dump mining trucks. The coal will be crushed at the mine site, and hauled to market in over-the-road coal trucks.

The mine is planned to produce approximately 5.02 million tons of coal over a life of approximately 3 years. The estimated production schedule is summarized below:

		Tons Produced
Year		(000)
1		2,000
2		2,000
3		1,016
Total		5,016

Initial mine development will involve removal and storage of topsoil from mine infrastructure locations. Facilities for equipment maintenance/warehouse, coal handling, and offices will be constructed. During the development and initial mining period, facilities temporary in nature may be used until permanent facilities can be built. Construction of sedimentation ponds, diversion ditches, and mine roads accessing the initial mining areas will also be ongoing.

Mining will employ typical open pit methods using truck/loader type equipment to remove overburden and recover the coal. Mining will advance across the property in successive cuts approximately 250 ft. in width and 800 to 1,300 ft. long (generally equal to the width of the property less property barriers). Layout of these pits can be viewed on Drawing 5-10. The overburden will be removed in layers or lifts approximately 20 to 40 feet deep. In practice, these overburden lifts are mined in a stairstep fashion ahead of the coal removal operation to provide adequate working room for the equipment and stable advancing slopes. Once mining is complete, excavated overburden (spoil) from a successive cut is used to backfill the excavation. General cross sections of this process can be viewed on Drawings 5-11 and 5-12.

Prior to beginning mining, the area will be cleared of vegetation, and the topsoil will be recovered and either stockpiled or live hauled to regraded areas. It is not anticipated that blasting of the overburden will be necessary based on drilling data. Should this process become necessary, this is the phase where it would be implemented. Overburden will then be removed using large hydraulic excavator(s) or front end loaders and off-road trucks which will haul the spoil and place it in parts of the pit where the coal has been removed, or in the excess spoil area shown on Drawings 5-3, 5-35 and 5-36. Overburden is removed in successively deeper benches until the coal seam is exposed. Some overburden in lower lifts may be moved by direct dozing into the mined out pit by large bulldozers.

When overburden removal is finished in a particular pit, the top of the coal will be cleaned (removal of any roof rock or other non-coal material on top of the seam) using a motor grader, dozer or front end loader. The material removed will be placed in the adjacent mined out pit. If necessary, the coal seam will be loosened by drilling and blasting or ripping prior to loading. Drilling and blasting of the coal is not expected to be necessary. The cleaned, exposed coal is then excavated by backhoe or front end loader and placed into off-road rear dump trucks.

Once the coal is removed, the pit will be backfilled by spoil from adjacent mine pits. Spoil will be placed in lifts and spread with a dozer. Once the pit is backfilled to the planned final surface contour, suitable topsoil and subsoil will be replaced, and the area reseeded. Revegetation work will proceed seasonally as appropriate for planting.

Overburden excavation and coal mining at Coal Hollow will begin near the subcrop of the coal seam at the western end of the permit area in the NW ¼ NE ¼ of Section 30, T39S, R5W. Topsoil will be removed and stored separately in topsoil stockpiles as shown on Map 2-2. Overburden from the initial pits will be hauled to the excess spoil pile east of the mining area. Once the initial pits are established, as much spoil as possible will be placed directly in the pit backfill, allowing reclamation to closely follow mining. This initial phase includes pits 1 through 8 as shown on Drawing 5-10. The mining and reclamation process for this phase can be viewed on Drawing 5-17.

From the initial mining area, operations will proceed eastward through the NE ¼ of Section 30 to the NW ¼ of Section 29 (as shown on Drawing 5-10). The mining and reclamation process for this phase can be viewed on Drawing 5-18. The pit will then turn south, and advance to the north edge of Section 31 T39S, R5W. This mining and reclamation phase can be viewed on Drawing 5-19. As shown on Drawing 5-19, the final pits will not be backfilled at this stage. The proposed method for filling these pits back to approximate original contour will be accomplished by utilizing overburden from the pit(s) in the adjacent federal reserves located immediately west of this area. Alton Coal Development, LLC is currently in the process of an Environmental Impact Study for these reserves with the intent of acquiring the rights to mine. It is expected that these rights will be acquired prior to the completion of the final phase in the proposed Permit Area. The final landform for the Permit Area is shown on Drawings 5-35 and 5-36.

In the case that Alton Coal Development, LLC is not successful with acquiring the rights to the adjacent federal coal reserves, spoil will be rehandled from the excess spoil and variance from the approximate original contour to fill the remaining pits. The final landform for this alternate scenario is shown on Drawing 5-37 and 5-37A.

An estimate of the primary mining equipment planned for use at the Coal Hollow Mine is listed below:

Diesel - Hydraulic Excavators (15 to 38 cu. yd. capacity).
Rubber Tired Front End Loaders (8 to 20 cu. yd. capacity)
End Dump Trucks (100 to 240 ton capacity class)
Track Dozers (Caterpillar D7 through D11 Class)
Motor Graders (Caterpillar 16H to 24H Class)
Water Trucks (8,000 to 20,000 Gallon Class)

A variety of other equipment will also be used to support the mining operation.

Proposed engineering techniques for meeting the proposed mining methods will include:

- Design support for roads, pits, sediment impoundments etc…
- Field staking of designs utilizing high precision GPS survey systems.
- Weekly field engineering support to view and provide guidance related to designs and environmental controls.
- Ongoing geotechnical support for ensuring highwall stability
- As additional information becomes available, update geological models to ensure full recovery of resource.
- Weekly mine plans that specify appropriate engineering and environmental specifications.

There are no known underground mines within 500 feet of the permit boundary; therefore, no surface mining or reclamation activities will take place within 500 feet of any underground mine.

524. BLASTING AND EXPLOSIVES

As a result of the 2005 drilling program and overburden characterization, it was determined that the soil over the coal seam is void of any solid structure and that the overburden is extremely homogenous consisting of soft clay and soft shale. As results of this cursory investigation, it is anticipated that there would be no need to drill and blast the overburden to facilitate the removal of the spoil above the coal seam. Also, due to the fact that the coal will have to be mined from on top of the seam due to wet clay zone beneath the coal seam it is anticipated that there would be no need to drill and blast the coal seam to facilitate coal removal.

As a safeguard or fallback position if mining condition should change, all blasting and explosive criteria will be addressed.

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Though not anticipated, explosives may be utilized as necessary at Coal Hollow Mine to break the overburden over the coal and may be used to break the coal for loading if necessary. In accordance with the requirements of this section, a blasting plan is provided to the Division in Appendix 5-4. Blasts that use more than five pounds of explosives or blasting agents will be conducted according to the schedule provided in 524.400.

524.100 Blaster Certification

Alton Coal Development, LLC (ACD) will, prior to conducting any surface blasting operations, ensure that all surface blasting incident to surface mining in Utah is conducted under the direction of a Utah Certified Blaster. Certificates of blaster certification will be carried by the blasters or will be on file at the mine permit area during blasting operations. A blaster and at least one other person will be present at the firing of a blast.

Persons responsible for blasting operations at a blasting site will be familiar with the blasting plan and site-specific performance standards and give on-the-job training to persons who are not certified and who are assigned to the blasting crew or assist in the use of explosives.

524.200 Blast Design

There are no dwellings, public buildings, schools, churches, or community or institutional building within 1,000 feet of the planned blasting area in the initial (year 1) mining period. There are also no underground mines within 500 feet of the permit. The anticipated blast design can not be reasonably estimated at this time since ACD is not sure what geologic conditions exist that may require blasting. If conditions are encountered that require blasting, ACD will provide the Division with the designed pattern prior to conducting blasting.

Blasts conducted within 1000 ft. of a dwelling, public building, school, church, or community or institutional building will be submitted for Division and MSHA approval, prior to blasting. The blast design will contain sketches of the drill and delay patterns, decking, type and amount of explosives required per blast, critical dimensions, design factors utilized to protect the public, general location drawings of protected structures, which meet the applicable airblast, flyrock, and ground vibration standards in 524.600.

The blast design will be prepared and signed by a Utah certified blaster.

524.300 - 350 Preblasting Survey

A preblasting survey will be conducted prior to commencement of blasting operations. As part of the preblasting survey Alton Coal Development LLC will:

- Notify, in writing, all residents or owners of dwellings or other structures located within one-half mile of the permit area how to request a preblasting survey at least 30 days before initiation of blasting.
- Prepare a written report of any preblasting survey. A resident or owner of a dwelling or structure within one-half mile of any part of the permit area may request a preblasting survey. This request will be made, in writing, directly to Alton Coal Development LLC or to the Division, who will promptly notify Alton Coal Development LLC. Alton Coal Development LLC will promptly conduct a

preblasting survey of the dwelling or structure and promptly prepare the written report. An updated survey of any additions, modifications, or renovation will be performed by Alton Coal Development LLC if requested by the resident or owner.

- Determine the condition of the dwelling or structure and will document any preblasting damage and other physical factors that could reasonably be affected by the blasting. Structures such as pipelines, cables, transmission lines, and cisterns, wells, and other water systems warrant special attention; however, the assessment of these structures may be limited to surface conditions and other readily available data.
- Require the written report of the survey be signed by the person who conducted the survey. Copies of the report will be promptly provided to the Division and to the person requesting the survey. If the person requesting the survey disagrees with the contents and/or recommendations contained therein, he or she may submit to both Alton Coal Development LLC and the Division a detailed description of the specific areas of disagreement.
- Complete any survey requested more than ten days before the planned initiation of blasting, before blasting occurs.

524.400 Blasting Schedule

524.420. Timing of Blasting

All blasting will be conducted between sunrise and sunset unless nighttime blasting is approved by the Division. Alton Coal Development LLC will conduct blasting operations at times approved by the Division and announced in the blasting schedule.

524.410. Unscheduled Blasts

Unscheduled blasts will be conducted only where public or operator health and safety so requires and for emergency blasting actions. When an unscheduled surface blast incidental to coal mining and reclamation operations is conducted, Alton Coal Development LLC, using audible signals, will notify residents within one-half mile of the blasting site and document the reason in accordance with 524.760.

524.450 - 453. Blasting Schedule Publication and Distribution.

Alton Coal Development LLC will:

- Publish the blasting schedule in a newspaper of general circulation in the locality of the blasting site at least ten days, but not more than 30 days, before beginning a blasting program;

- Distribute copies of the schedule to local governments and public utilities and to each local residence within one-half mile of the proposed blasting site described in the schedule; and
- Republish and redistribute the schedule at least every 12 months and revise and republish the schedule at least ten days, but not more than 30 days, before blasting whenever the area covered by the schedule changes or actual time periods for blasting significantly differ from the prior announcement; and

524.460 - 465. Blasting Schedule Contents.

The blasting schedule will contain, at a minimum:

- Name, address, and telephone number of operator;
- Identification of the specific areas in which blasting will take place;
- Dates and time periods when explosives are to be detonated;
- Methods to be used to control access to the blasting area; and
- Type and patterns of audible warning and all-clear signals to be used before and after blasting.

524.500 - 532 Blasting and Warning Signs, Access Control

Blasting signs will read **"Blasting Area"** and be conspicuously placed along the edge of any blasting area that comes within 100 feet of any public right-of-way, and at the point where any other road provides access to the blasting area. At all entrances to the mine permit area from public roads or highways, signs will be conspicuously placed which read **"Warning! Explosives in Use"**, clearly list and describe the meaning of the audible blast warning and all-clear signals in use, and explain the identification of blasting areas where charged holes await firing at the blasting site in the mine permit area.

Warning and all-clear signals of different character or pattern that are audible within a range of one-half mile from the point of the blast will be given. Each person within the permit area and each person who resides or works regularly within one-half mile of the blast site in the mine permit area will be notified of the meaning of the signals in the blasting schedule and notification.

Access within the blasting areas will be controlled to prevent presence of livestock or unauthorized persons during blasting and until an authorized representative of Alton Coal Development LLC has reasonably determined that no unusual hazards exist, such as imminent slides or un-detonated charges; and access to and travel within the blasting area can be safely resumed.

524.600 - 610 Adverse Effects Of Blasting

Blasting will be conducted to prevent injury to persons, damage to public or private property outside the mine permit area, and changes in the course, channels, or availability of surface or ground water outside the mine permit area.

524.620 Airblast Limits

Airblast will not exceed the maximum limits listed below at the location of any dwelling, public building, school, church, or community or institutional building outside the mine permit area, except for those structures and facilities owned by Alton Coal Development LLC as approved by the Division. Maximum airblast limits are as follows:

Lower Frequency Limit of Measuring System, HZ (+3dB)		Maximum Level dB
0.1 Hz or lower – flat response (1)		134 peak
2 Hz or lower – flat response		133 peak
6 Hz or lower – flat response		129 peak
C-weighed – slow response (1)		105 peak dBC

(1) Only when approved by the Division.

524.630. Monitoring:

Periodic monitoring will be conducted to ensure compliance with the airblast standards. Airblast measurements and will be taken as required by the Division at locations specified by the Division. The measuring system used will have an upper-end flat frequency response of at least 200 Hz.

524.633. Flyrock:

Flyrock traveling in the air or along the ground will not be cast from the blasting site more than one-half the distance to the nearest dwelling or other occupied structure; beyond the area of blasting access control or beyond the mine permit area boundary.

524.640 - 662. Ground Vibration.

In all blasting operations, except as otherwise authorized by the Division, the maximum ground vibration will not exceed the values approved by the Division. The maximum ground vibration for protected structures will be in accordance with either the maximum peak-particle velocity limits, the scaled-distance equation, the blasting-level chart, or by the Division. All other structures in the vicinity of the blasting area such as water towers, pipelines and other utilities, tunnels, dams, impoundments, and underground mines will be protected from damage by establishment of a maximum allowable limit on the ground vibration. These limits will be submitted by Alton Coal Development LLC and approved by the Division prior to blasting. A seismographic record will be provided for each blast.

Maximum Peak-Particle Velocity Method: The maximum ground vibration will not exceed the following limits at the location of any dwelling, public building, school, church, or community or institutional building outside the mine permit area in accordance with the following:

Distance (D) from Blast Site in feet	Maximum allowable Particle Velocity (Vmax) for ground vibration, in inches/second (1)	Scaled distance factor to be applied without seismic monitoring (Ds) (2)
0 to 300	1.25	50
301 to 5,000	1.00	55
5,001 and beyond	0.75	65

(1) Ground vibration will be measured as the particle velocity. Particle velocity will be recorded in three mutually perpendicular directions. The maximum allowable peak particle velocity will apply to each of the three measurements.
(2) Applicable in the scale-distance equation of 524.651.

Scaled Distance Equation Method: Alton Coal Development LLC will use the scaled-distance equation, $W=(D/Ds)^2$, to determine the allowable charge weight of explosives to be detonated in any eight-millisecond period, without seismic monitoring: where W = the maximum weight of explosives, in pounds: D = the distance, in feet, from the blasting site to the nearest protected structure: and Ds = the scaled-distance factor, which may initially be approved by the Division using the values for scaled-distance factor listed in 524.642.

The development of a modified scaled-distance factor may be authorized by the Division on receipt of a written request by Alton Coal Development LLC, supported by seismographic records of blasting at the mine site. The modified scaled-distance factor of the predicted ground vibration will not exceed the prescribed maximum allowable peak particle velocity of 524.642 at a 95% confidence level.

Blasting-Level-Chart. Alton Coal Development LLC may use the ground-vibration limits in Figure 1 (Figure 1, showing maximum allowable ground particle velocity at specified frequencies, is incorporated by reference. Figure 1 may be viewed at 30 CFR 817.67 or at the Division of Oil, Gas and Mining State Office.) to determine the maximum allowable ground vibration. If the Figure 1 limits are used, a seismographic record including both particle velocity and vibration-frequency levels will be provided for each blast. The method for the analysis of the predominant frequency contained in the blasting records will be approved by the Division before application of this alternative blasting criterion.

524.690. <u>Standards not Applicable</u>

The maximum airblast and ground-vibration standards of 524.620 through 524.632 and 524.640 through 524.680 will not apply at the following locations: At structures owned by Alton Coal Development LLC and not leased to another person; and at structures owned by Alton Coal Development LLC and leased to another person, if a written waiver by the lessee is submitted to the Division before blasting.

524.700 Records of Blasting Operations:

Blasting records will be maintained at the mine site for at least three years and upon request, records will be available for inspection by the Division or the public. A blasting record will contain the name of Alton Coal Development LLC; location, date, and time of the blast; name, signature, and Utah certification number of the blaster conducting the blast. It will also include the identification, direction, and distance, in feet, from the nearest blast hole to the nearest dwelling, public building, school, church, community or institutional building outside the permit area, except those described in 524.690 and weather conditions, including those which may cause possible adverse blasting effects.

The blasting record will include: The type of material blasted; sketches of the blast pattern including number of holes, burden, spacing, decks, and delay pattern; diameter and depth of holes; types of explosives used; total weight of explosives detonated in an eight-millisecond period; initiation system; type and length of stemming; and mats or other protection used.

If required, a record of seismographic and airblast information will include: type of instrument, sensitivity, and calibration signal or certification of annual calibration; exact location of instrument and the date, time, and distance from the blast; name of the person and firm analyzing the seismographic record; and the vibration and/or airblast level recorded; and the reasons and conditions for each unscheduled blast.

524.800 Use of Explosives:

Alton Coal Development LLC will comply with all appropriate Utah and federal laws and regulations in the use of explosives.

526. MINE FACILITIES:

526.110-115 Existing Structures.

There are no existing structures within the permit area.

526.116. Public Roads:

526.116.1. Operations Within 100 ft. of a Public Road

Initial mining operations at the Coal Hollow Mine will be on the western edge of the property, and will require rerouting Kane County Road #136 so that operations do not come within 100 feet of this road. During the initial development phase (topsoil removal, diversion construction, etc..), equipment traffic may cross the county road right-of-way to access the necessary area. see Drawing 5-3. Details related to the road relocation can be viewed on Drawing 5-3 and in Appendix 1-7.

526.116.2 Relocating a Public Road:

Following the initial development period, Kane County will temporarily relocate County Road #136 (K3900) to federal lands located west of the permit area which are managed by the BLM. This relocation will bypass the permit area for the duration of mining operations and is shown on Drawing 5-3. Details of agreements and appropriate approvals for this road relocation are located in Appendix 1-7. The relocated road is not within 100 ft. of mining or reclamation operations. The design and route of the relocated road has been approved by Kane County authorities and the BLM. Kane County will continue to have sole jurisdiction and will maintain it as a public road. Following completion of mining operations within the permit area, Kane County will reestablish the road to the approximate original location and will also reclaim the temporary road as required by the BLM. The existing road from the north relocation diversion point to the permit boundary will also continue to be maintained as a public road by Kane County. Once the road intersects the permit boundary, appropriate signs and barricades will be installed to protect the public.

526.200 Utility Installation and Support Facilities

526.210 Existing Utilities.

There are no known oil, gas, and water wells; oil, gas, and coal-slurry pipelines, railroads; electric and telephone lines; and water and sewage lines passing over, under, or through the permit area. Should such facilities be installed, mining and reclamation operations will be conducted in a manner that minimizes damage, destruction, or disruption of services provided by such facilities unless otherwise approved by the owner of those facilities and the Division.

526.220 Support Facilities

The mine support facilities will include an office, shop, wash bay, oil containment, fuel containment, coal stacking system, coal loadout system and an equipment parking area These facilities will be constructed on an isolated section of the permit area that is approximately 34 acres. This area is located immediately north of Lower Robinson Creek, in Township 39 South, Range 5 West, Section 19. A diversion ditch will route water from the upgradient area immediately east of the area around the facilities and into a tributary of Lower Robinson Creek as shown on Drawing 5-3. Storm water and snow melt that occurs within the facilities area will be routed to an impoundment that will contain sediment. This impoundment will have a drop-pipe spillway installed that will allow removal of any oil sheens that may result from parking lots or maintenance activities by using absorbent materials to remove the sheen. In addition to this pond, an additional small impoundment will also be located in the southwest corner of the facilities area to control drainage from the mine access road. Details for these impoundments can be viewed on Drawings 5-28 and 5-28B.

The following is a detailed description of each proposed facility and a reference to where detailed drawings can be found:

- Office: The office will be located on the northwest corner of the facilities area, immediately adjacent to the facilities access road. This building will be a steel structure with concrete footers. This structure will be 150 feet long by 100 feet wide and will be two stories in height. The office will provide working space for administrative and technical personnel. Details for the office can be viewed of Drawings 5-3 and 5-6.
- Shop: The shop will be located on the northeast side of the facilities area. This building will be a steel structure with concrete floors and foundation. The structure will be approximately 200 feet long by 100 feet wide and 50 feet high. This building will be used for maintenance of equipment, parts storage, tool storage, and office space for maintenance personnel. Details for this building can be viewed on Drawings 5-3 and 5-7.
- Wash Bay: The wash bay will be located immediately east of the shop. This building will be a steel structure with a concrete foundation. The structure will be 50 feet long by 60 feet wide and 50 feet high. Included will be a closed circuit water recycle system. This system will eliminate and store water impurities and reroute water back through the wash bay for cleaning equipment. Details for this structure can be viewed on Drawings 5-3, 5-8, and 5-8A.
- Oil and Fuel Containments: The oil and fuel containments will be concrete structures appropriately sized for containing metal tanks. The oil containment will contain 55 gallon barrels and up to 2,000 gallon totes. This containment will be 80 feet long by 30 feet wide and 3 feet deep. The fuel containment will store 3 fuel tanks. Included will be a 4,000 gallon unleaded fuel tank and two 12,000 gallon diesel tanks. This structure will 50 feet long by 30 feet wide and 3 feet deep. Details for this structure can be viewed on Drawings 5-3 and 5-8.
- Coal Stacking System: The coal stacking system will be located in the central part of the facilities area. This system will include a coal hopper, coal feeder breaker, feed conveyor, crusher, and an inclined conveyor belt. Trucks will dump coal into the coal hopper which will funnel coal through the feeder breaker onto a short feed conveyor belt. This conveyor belt will transport the coal approximately 195 feet to a crusher that will size the coal appropriately for market. Once the coal is sized through the crusher it will enter an inclined stacker conveyor belt that is angled at approximately 16 degrees and is 186 feet long. This system will be a radial conveyor which will feed a coal stock pile with a live storage of approximately 50,000 tons. This system can be viewed on Drawings 5-3 through 5-5.
- Coal Loadout System: The coal loadout system will be located in the central part of the facilities area. This system will include an above ground reclaim feeder, a coal reclaim conveyor and an inclined conveyor. The reclaim feeder will be loaded by a dozer pushing the coal onto the feeder. One inclined conveyor that is approximately

290 feet in length will convey the coal from the feeder to the loadout hopper. This loadout hopper will load highway approved haul trucks that transport coal to market.

- Minor Facilities: The minor facilities will include a septic vault at the office (Drawing 5-6), a power washing and water recycle system in the Wash Bay (Drawing 5-8A), conduit with electrical lines running from generators to various facilities (Drawing 5-8B), Water System (Drawing 5-8C), an Equipment Hotstart Area (Drawing 5-3, 5-8B) and a Field Hydrant (Drawing 5-4, 5-5, 5-8B).
- Electrical System: The electrical system for the facilities at Coal Hollow will consist of two diesel fuel powered generators. One generator is a 750 KVA unit that will provide electricity to all the buildings. The other generator is a 1200 KVA unit that will be used to supply electricity to the coal conveying, sizing, stockpiling and loading system. The anticipated layout of the electrical system is shown on Drawing 5-8B.
- Dust Control Structures: A water system will be constructed to provide water for non-potable uses at the facilities and also for fugitive dust control measures. This system will consist of a water well, 6" water transport pipe, and two 16,000 gallon water tanks. The first water tank will be placed near the mining area and will be used specifically to load the water truck which will spray water on the active roads within the permit area to control dust. The second tank is located at the facilities area to provide a water supply to the facilities for non-potable uses (cleaning equipment, restrooms, etc...). Further details related to this water system can be viewed on Drawing 5-8C.

During mine development and the initial mining period, some facilities of a temporary nature such as mobile buildings and crusher/stacking conveyors may be utilized.

Support facilities to provide lighting at night will be kept to a minimum but will need to be sufficient enough to provide safe operating conditions in the dark. The following lighting equipment is anticipated to be used to provide safe working conditions:

- Two to three mobile light plants: Each light plant will have up to four 1,000 watt lights.
- Four to six exterior lights at the facilities area for lighting walkways and miscellaneous work areas: Each of these is expected to be 250 watt lights.
- Lights on mobile mining equipment, support vehicles and building lights

The support facilities will be located, maintained, and used in a manner that prevent or control erosion and siltation, water pollution, and damage to public or private property; and to the extent possible use the best technology currently available to minimize damage to fish, wildlife, and related environmental values; and minimize additional contributions of suspended solids to stream flow or runoff outside the mine permit area. Any such contributions will not be in excess of limitations of Utah or Federal law.

The facilities will be fully reclaimed at the end of mining operations with the exception of the water well. The final contour for this area can be viewed on Drawing 5-35 and 5-37 and an anticipated timetable is shown on Drawing 5-38.

526.300 Water Pollution Control Facilities:

Water pollution associated with mining and reclamation activities within the permit areas will be controlled by:

- Construction of berms and/or diversion ditches to control runoff from all facilities areas.
- Roads will be constructed with ditches to capture runoff
- Diversion ditches will be constructed as necessary around active mining and reclamation areas to capture runoff from those areas.
- Sedimentation impoundments will be constructed to control discharges
- In areas where impoundments or diversions are not suitable to the surrounding terrain, silt fence or other appropriate structures will be utilized to control sediment discharge from the permit area.

In order to accomplish these objectives, watershed analysis of the permit and adjacent areas has been completed and specific designs are established for each water pollution control structure. Primary control structures include five sediment impoundments, four diversion ditches and miscellaneous berms. The locations of these structures can be viewed on Drawing 5-3. The detailed analysis for these structures and specific designs can be viewed on Drawings 5-25 through 5-34. In addition, a geotechnical analysis of the impoundments to ensure stability can be viewed in Appendix 5-1. The watershed and structure sizing analysis can be viewed in Appendix 5-2.

In addition to these primary structures, temporary diversions and impoundments may also be implemented, as necessary, in mining areas to further enhance pollution controls.

All these facilities will be reclaimed to approximate original contour. The reclamation sequence and final landform can be viewed on Drawings 5-35 and 5-38.

526.400 Air Pollution Control Facilities:

Air pollution (fugitive dust) emissions from mining and reclamation operations in the permit area will be controlled by a number of means, including:

- Haul roads will be maintained and will have water or other dust suppressants applied as appropriate.
- Road surfaces will be graded to stabilize/remove dust-forming debris as required.
- Areas adjoining primary roads will be stabilized and vegetated as required.
- Mobile equipment speeds will be controlled to minimize dusting conditions.
- Cleared vegetation debris within the mine area will be disposed of by placement in pit backfills.

A water system will be constructed to provide water for non-potable uses at the facilities and also for fugitive dust control measures. This system will consist of a water well, 6” water transport pipe, and two 16,000 gallon water tanks. The first water tank will be placed near the mining area and will be used specifically to load the water truck which will spray water on the active roads within the permit area to control dust. The second tank is located at the facilities area to provide a water supply to the facilities for non-potable uses (cleaning equipment, restrooms, etc…). Further details related to this water system can be viewed on Drawing 5-8C.

For details related to air pollution control and monitoring, refer to Chapter 4 and Appendix 4-2 and 4-5.

527. TRANSPORTATION FACILITIES

527.100 Classification of Roads

Primary roads are any road that is used to transport coal or spoil and is frequently used for access or other purposes for a period in excess of six months; or is to be retained for an approved postmining land use. The following is the roads that meet the classification of a primary road based on this standard:

Roads used to transport coal or spoil in excess of six months

There are two roads that will be used to transport coal or spoil in excess of six months and are referred to as "Year 1 and 2 Mine Haul Road" and "Year 2 and 3 Mine Haul Road". These two roads will be the main accesses for the pits throughout the life of the mine. Details for these two roads are provided in Section 527.200 and on Drawings 5-22 and 5-23. In addition to these two roads, the road located within the facilities area is also classified as a primary road. This road is referred to as "Facilities Roadway" and details are described in 527.200 along with Drawings 5-22A and 5-22B.

Roads retained for an approved postmining land use

Roads retained for an approved postmining land use include the following: Access to East Pugh Property, County Road 136 (K3900), Access to Water Well and Road to Swapp Ranch. Details and locations for these roads are shown on Drawings 5-35, 5-37, 5-22A, 5-22B, 5-22C, 5-22D, 5-22E, 5-22F and 5-22G.

All other roads planned for construction within the permit area will be classified as ancillary. These will include temporary ramps, benches and equipment travel paths within the active mining area.

527.200 Description of Roads

Roads for the Coal Hollow Mine include seven primary roads, a conveyor system, and miscellaneous ancillary/temporary roads. Numerous drawings detail the designs and specifications for each one of the proposed facilities. The following is a description of each facility and a reference for the associated drawings:

- Roads: Two primary mine haul roads are planned within the permit area. The first road extends from the coal unloading area to the first series of pits along the west side of the property. This road will be utilized for access to pits 1 through 15 (pits shown on Drawing 5-10). This road will be approximately 2,600 feet in length and will be utilized mainly during the first two years of mining. There will be three culverts installed along this road all sized for a 100 year, 24 hour storm event. The first culvert will be across a tributary of Lower Robinson Creek and will be a 36 inch corrugated steel pipe. The second culvert is the main crossing over Lower Robinson Creek and is a 96 inch corrugated steel pipe. Both of these culverts have been sized based on analysis of the Lower Robinson Creek watershed. This analysis can be viewed in Appendix A5-3. The third culvert is crossing over a diversion ditch that will route water mainly from disturbed areas along the south side of Lower Robinson Creek to a sediment impoundment. This culvert will be a 24 inch corrugated steel pipe.

  The second road extends from an intersection with the first road, located just south of the Lower Robinson Creek crossing, and proceeds south to approximately pit 25. This road is approximately 2,500 feet in length and will be used for the south pits 16 through 30. There is one culvert crossing along this road to cross a diversion ditch. This culvert will be a 24 inch culvert sized for maximum anticipated flows in the diversion.

  The following specifications apply to these Primary mine haul roads:
    1) Roads will be approximately 80' in width
    2) Approximately a 2% crown
    3) Approximately one foot deep cut ditches along shoulders for controlling storm water
    4) 18" of crushed rock or gravel for road surfacing
    5) Cut and fill slopes of 1.5 h:1v
    6) Minimum fill over each culvert will be 2 times diameter of culvert
    7) Berms placed as necessary along fills

  The ancillary roads will have similar specifications except surfacing will occur only as needed and may be narrowed to a 40 foot road width. A typical cross section for the ancillary roads can be viewed on Drawing 5-24.

  The location and details for Primary Mine Haul roads can be viewed on Drawings 5-3 and 5-22 and 5-23.

  In addition to the two roads primary Mine Haul roads, the road located within the facilities area is also classified as a primary road. This road is planned to be 24 feet wide with 24 inches of compacted sub base and 8 inches of compacted 1 inch minus gravel as surfacing. This road is referred to as "Facilities Roadway" and more details are described in 527.200 along with Drawings 5-22A and 5-22B.

In addition to the primary roads that will be present during active mining, four additional roads are planned to exist postmining and are also classified as primary roads for this reason.

Roads that will remain postmining are the following:

- Road to Water Well with details shown on Drawing 5-22D
- Road to east C. Burton Pugh property with details shown on Drawing 5-22C
- County Road 136 (K3900) with details on Drawing 5-22E, 5-22F and 5-22G. This County road will be reconstructed within the permit area by Kane County. This reconstruction will occur concurrently with the final stage of reclamation as scheduled on Drawing 5-38 and is expected to be completed by the end of Year 4.
- Road to Swapp Ranch (same specification as the Water Well Road)

The location of these roads is shown on Drawings 5-35 and 5-37 along with the post mining topography.

The ramps, benches and equipment travel paths within the active surface mining area are temporary in nature and will be relocated frequently as mining progresses. These temporary travelways are considered part of the pit due to their short term use, and are not individually designed nor engineered. They will be built and maintained to facilitate safe and efficient mine and reclamation operations.

- Conveyors: A conveyor system will be used to stockpile coal and to load highway approved haul trucks for transportation to market. The first conveyor is mainly a stacker system for the coal stockpile which will be located at the coal unloading area and will be approximately 451' in length. This conveyor is estimated to be a 48" solid frame system.

  The second conveyor is a coal reclaim belt that will be loaded by an above ground reclaim feeder from the coal stockpile and will convey coal to the loadout chute which will load the highway approved coal haulage trucks. This section will be approximately 290' in length. Similar to the first section, this conveyor is estimated to be a 48" solid frame system.

  Drawings of this system can be viewed on Drawings 5-3 through 5-5.

527.220 <u>Alteration or Relocation of Natural Drainageways</u>.

As currently planned, no natural drainageways will be altered or relocated due to road construction, though a temporary diversion of Lower Robinson Creek will be constructed to allow for maximum recovery of coal. This temporary diversion of Lower Robinson Creek is not being constructed to facilitate road construction. If any other alterations or relocations are necessary, appropriate measures will be taken to obtain Division approval for such alterations or relocations.

Mine development work will include a temporary diversion of Lower Robinson Creek away from the mining area. This diversion has been designed for a flow capacity of a 100 year, 24 hour storm event. The sides will be graded to a 3h:1v slope and rip-rap will be appropriately placed to minimize erosion of the channel beyond current channel conditions. All specifications required to meet the requirements for such a diversion have been included in this diversion design. Appendix 5-2 details the analysis/specifications for this diversion and Drawings 5-20 and 5-21 show the details of this design.

As part of the reclamation process, Lower Robinson Creek will be reconstructed to its approximate original location. The design for this reconstruction is shown on Drawings 5-20A and 5-21A. This design includes considerable improvements to the channel compared to the channel's current condition. The current condition is such that less than 25% of the channel within the disturbed area has a flood plain present and most of the slopes are near the angle of repose with fair to poor vegetative cover. The reconstructed channel includes stable slope angles that will be revegetated with a flood plain on both sides of the channel for the entire length reconstructed. Sharp corners in the original alignment have been rounded to sinuous curve shapes and rip-rap will be installed in the bottom section of the channel to minimize erosion. The flood plain will seeded and covered with erosion matting to control erosion until a natural vegetative condition can be attained.

527.230 Road Maintenance

All roads will be maintained on an as needed basis using motor graders, water trucks for dust suppression, and other equipment as necessary. Crushed stone and/or gravel will be used as a surface course for primary roads outside the active mining area, and may be used as needed for ramps and travelways within the pit. Should the roads be damaged by a catastrophic event, such as an earthquake or a flood, repairs will be made as soon as possible after the damage has occurred or the road will be closed and reclaimed.

527.250. Geotechnical Analysis

No alternative specifications or steep cut slopes associated with roads are anticipated outside the active mine area. A report of appropriate geotechnical analysis will be provided should such alternative specifications or steep cut slopes where approval of the Division is required, become necessary.

528. HANDLING AND DISPOSAL OF COAL, OVERBURDEN, EXCESS SPOIL, AND COAL MINE WASTE:

528.100. Coal removal, handling, storage, cleaning, and transportation areas and structures;

Coal handling activities are confined to the active pit, and the coal sizing/loading areas located north of the pit. All areas and facilities will be designed and constructed, utilized and maintained in conformance with industry standards and all applicable regulations. At the conclusion of mining, the facilities will be removed as part of final mine reclamation activities. Material from coal stockpile areas, and other areas of potential coal accumulation will be excavated and the excavated material placed in the final mined out pit.

528.200. Overburden;

Overburden will be excavated after the removal of topsoil and subsoil as defined in Chapter 2. The overburden excavation will be accomplished by utilizing hydraulic excavators with end dump haul trucks and dozers. This process will include excavating this material in a stairstep fashion that will include benches approximately every 40 feet in depth. These benches are planned to be approximately 40 feet in width and will create an overall 2h:1v slope for the highwalls to create a stable and safe working area. This is a conservative approach for initial mining and once mining begins, ongoing geotechnical studies and monitoring will be used to further define the proper slope angle to ensure slope stability while maximizing resource recovery.

Based on the overburden isopach map (Drawing 5-15), the overburden removal has been separated into three major stages. The first stage of overburden removal is the initial mining area, Pits 1-8. These pits have a relatively low strip ratio, approximately 5:1 (refer to Drawing 5-13). In order to efficiently remove overburden for this phase, spoil from the first three pits will be placed in an excess spoil area. This excess spoil structure will hold approximately 2.7 million loose cubic yards (LCY) of material. Once the excess spoil pile is filled, overburden from Pits 4 through 8 can then be used as pit backfill as the mining progresses through Pit 8. The completion of this phase is shown on Drawing 5-17.

As mining progresses through Pits 9-15, the isopach (Drawing 5-15) shows that the overburden significantly increases. This increase and the shape of the mining boundary for the Permit Area requires a fill above approximate original contour. Material from Pits 9-15 significantly exceeds the backfill capacity available from the preceding pits (Pits 1-8). The fill above approximate original contour blends in with the excess spoil structure from Stage 1 and extends an additional 2,500 feet to the east as the mining sequence proceeds to Pit 15. In this stage, the fill above original contour is approximately 5.8 million LCY. Drawing 5-18 (Stage 2) shows the details of this stage of the overburden removal and resulting landform.

Stage 3 overburden removal begins in Pit 16 and proceeds through Pit 30. During this stage, the strip ratio reduces significantly from Stage 2 as mining progresses to the south end of the property. As the strip ratio reduces to the south, significant backfill capacity is available in the preceding pits. This results in the distance between the backfill and the active coal face increasing. At the end of mining, an area will not be completely backfilled that is approximately 2,000 feet in length and 1,300 feet wide and will require 6.8 million yards of fill to complete reclamation to approximate original contour. The backfill configuration at the end of this stage is shown in Drawing 5-19.

The proposed plan for backfilling these final pits includes acquiring the right to mine the adjacent federal coal reserves, located immediately west of this area. This plan provides an efficient method for transitioning operations into the federal reserves. At the time that this transition occurs, overburden will be removed from the federal reserves and placed in the final pits to approximate original contour. This final landform can be viewed on Drawing 5-35 and 5-36.

In the case that Alton Coal Development is not successful with acquiring the adjacent federal coal reserves, all the fill above approximate original contour and part of the excess spoil structure will be rehandled and placed back in the remaining backfill area. The final landform for this scenario is shown on Drawing 5-37. This step requires rehandle of approximately 6.8 million yards of spoil.

The following tables show the material balance during the different phases of overburden removal for each scenario:

Preferred Scenario (Adjacent Federal Reserves Acquired)				
Phase	Overburden (LCY)	Available Backfill (LCY)	Excess Spoil (LCY)	Total Excess Spoil (LCY)
1	7,945,000	5,204,000	2,741,000	2,741,000
2	15,145,000	9,303,000	5,842,000	8,583,000
3	15,447,000	22,247,000	0	8,583,000
4 (Federal)	6,800,000	6,800,000	0	8,583,000
Total	45,337,000	36,754,000	8,583,000	8,583,000

*Loose Cubic Yards is estimated based on an overall 22% swell factor (Caterpillar Performance Handbook)

Alternate Scenario (Adjacent Federal Reserves Not Acquired)				
Phase	Overburden (LCY)	Available Backfill (LCY)	Excess Spoil (LCY)	Total Excess Spoil (LCY)
1	7,945,000	5,204,000	2,741,000	2,741,000
2	15,145,000	9,303,000	5,842,000	8,583,000
3	15,447,000	22,247,000	0	8,583,000
4 (Rehandle)	0	6,800,000	-6,800,000	1,783,000
Total	38,537,000	36,754,000	1,783,000	1,783,000

*Loose Cubic Yards is estimated based on an overall 22% swell factor (Caterpillar Performance Handbook)

The Preferred scenario for overburden removal will minimize overall disturbance and maximize resource recovery by providing a transition into the adjacent federal reserves with minimal effect to existing reclamation and backfill in the Permit Area. This scenario will also minimize variances from approximate original contour on the federal lands by eliminating the need for an excess spoil structure from the initial boxcut once operations are transitioned into these reserves.

During the course of mining, some additional excavated overburden may be placed temporarily on mined over and backfilled areas due to operational considerations. This material will be re-excavated and moved to it's final placement location as operations allow.

All maps related to the overburden removal process can be viewed on Drawings 5-15 through 5-19.

528.300. <u>Spoil, coal processing waste, mine development waste, and noncoal waste removal, handling, storage, transportation, and disposal areas and structures;</u>

528.310. <u>Excess Spoil</u>. Excess spoil will be placed in designated disposal areas within the permit areas, in a controllable manner to ensure mass stability and prevent mass movement during and after construction. Excess spoil will meet the design criteria of R645-301-535. For the purposes of SURFACE COAL MINING AND RECLAMATION ACTIVITIES, the permit application must include a description of the proposed disposal site and the design of the spoil disposal structures according to R645-301-211, R645-301-212, R645-301-412.300, R645-301-512.210, R645-528.310, R645-301-535.100 through R645-301-535.130, R645-301-535.300 through R645-301-535.500, R645-536.300, R645-301-542.720, R645-301-553.240, R645-301-745.100, R645-301-745.100, R645-301-745.300, and R645-301-745.400.

Excess spoil will be placed in the area designated on Drawing 5-3 and 5-35. This fill will be placed in lifts not to exceed 4 feet in thickness. The material will be transported from the overburden removal area to the fill by end dump haul trucks and a dozer(s) will spread the spoil to this lift thickness. The fill will meet at minimum 85% compaction as related to the standard Procter. Final slopes will be regraded to a maximum slope of 3h:1v. The top of the fill will be sloped to approximately 2% to prevent pooling of water and to reestablish drainage similar to original flow patterns. The excess spoil placed on the non-mined areas is approximately 32 acres and varies in height from 35 to 120 feet. The area of excess fill over mined out areas (variance from approximate original contour) is an extension of the fill placed on the non-mined area and is approximately 55 acres. Combined acreage of the excess fill placed on mined and non-mined areas is 87 acres and varies in height from 60 to 100 feet above original contour. Total excess fill is 8.6 million yards. Design of this fill can be viewed in Drawings 5-35 through 5-36 and the geotechnical study can be viewed in Appendix 5-1.

- *R645-301-211: The applicant will present a description of the premining soil resources as specified under R645-301-221. Topsoil and subsoil to be saved under R645-301-232 will be separately removed and segregated from other material.*

  The soil resources for the proposed excess spoil disposal area are described in Appendix 2-1. A plan has been developed for removal of topsoil and suitable subsoil based on the soil descriptions in this appendices. The handling plan can be viewed on Drawing 2-2. Topsoil and acceptable subsoil will be separately removed and segregated from other material prior to placement of any spoil.

- *R645-301-212: After removal, topsoil will be immediately redistributed in accordance with R645-301-242, stockpiled pending redistribution under R645-301-234, or if demonstrated that an alternative procedure will provide equal or more protection for the topsoil, the Division may, on a case-by case basis, approve an alternative;*

  Excess spoil will have topsoil and subsoil redistributed in an approximately uniform, stable thickness with the approved post mining land use, contours and surface water drainage systems. Material handling practices will prevent excess compaction of these materials. Handling practices will also protect the materials from wind and water erosion before and after seeding and planting. These practices include seeding and grading stockpiles that will exist for more than year to stabilize the soil.

- *R645-301-412.300: Criteria for Alternative Postmining Land Uses.*

  The MRP does not contemplate Alternative Postmining Land Uses.

- *R645-301-512.210: Excess Spoil. The professional engineer experienced in the design of earth and rock fills will certify the design according to R645-301-535.100.*

  A professional engineer experienced in the design of earth and rock fills with assistance from a geotechnical expert has certified the design according to R645-301-535.100. These certifications can be viewed on Drawings 5-35, 5-36 and 5-17 through 5-19.

- *R645-301-512.220: Durable Rock Fills*

  No durable rock fills are planned.

- *R645-301-514.100: Excess Spoil. The professional engineer or specialist will be experienced in the construction of earth and rock fills and will periodically inspect the fill during construction. Regular inspections will also be conducted during placement and compaction of fill materials.*

  A professional engineer or specialist that is experienced in the construction of earth and rock fills will inspect the fill during construction and regular inspections will also be conducted during placement and compaction of fill materials.

- *R645-301-535.100 through R645-301-130: Disposal of Excess Spoil*

  A geotechnical analysis of the excess spoil structure design has been completed by an expert in this field. The long term static safety factor for this structure design is estimated at 1.6 to 1.7. Lifts will be placed in thicknesses not to exceed 4 feet. The lifts will meet 85% compaction by the standard Procter. The fill will be graded to allow for drainage similar to original patterns and to prevent excessive infiltration of water. Fill will be covered with subsoil and topsoil as specified in Chapter 2 to provide conditions suitable for revegetation of the area. The geotechnical study can be viewed in Appendix A5-1.

- *R645-301-535.300 through R645-301-535.500: Disposal of Excess - Spoil Durable Rock Fills.*

  No durable rock fills are planned.

- *R645-301-536.300: Disposal of Coal Mine Waste in Excess Spoil*

  No coal mine waste is planned in the excess spoil area.

- *R645-301-542.720: Excess spoil will be placed in designated disposal areas within the permit area, in a controlled manner to ensure that the final fill is suitable for reclamation and revegetation compatible with the natural surroundings and the approved postmining land use. Excess spoil that is combustible will be adequately covered with noncombustible material to prevent sustained combustion. The reclamation of excess spoil will comply with the design criteria under R645-301-553.240.*

  The excess spoil as shown in Drawing 5-35 and 5-36 will be suitable to the surrounding area and for the postmining land use of primarily grazing. No combustible excess spoil will be placed in the proposed structure. The final reclamation of the spoil does not include any terraces and the slopes will not exceed 3h:1v.

- *R645-301-553.240: The final fill configuration of the fill (excess spoil) will be suitable for the approved postmining land use. Terraces may be constructed on the outslope of the fill if required for stability, control of erosion, to conserve soil* *moisture, or to facilitate the approved postmining land use. The grade of the outslope between terrace benches will not be steeper than 2h:1v (50 percent).*

The excess spoil as shown in Drawings 5-35 and 5-36 will be suitable to the surrounding area and for the postmining land use of primarily grazing. The reclamation of the spoil does not include any terraces and the slopes will not exceed 3h:1v. The long term static safety factor for these slopes is estimated to be 1.6 to 1.7.

- *R645-301-745.100: General Requirements.*

745.110: Excess Spoil will be placed in designated disposal areas within the permit area, in a controlled manner to:

745.111: Minimize the adverse effects of leaching and surface water runoff from the fill on surface and underground water;

Reclamation of the excess spoil will include a topsoil cover and subsoil layer. Infiltration through the reclamation is expected to be minimal based on the high clay content of these soils. In addition, laboratory data for the overburden shows that there is minimal potential for leaching of pollutants should infiltration rates become higher than expected.

The foundation of the excess spoil area also has high clay content with minimal potential for infiltration. This will provide an additional, natural barrier to protect ground water present beneath the proposed structure.

745.112: Ensure permanent impoundments are not located on the completed fill. Small depressions may be allowed by the Division if they are needed to retain moisture or minimize erosion, create and enhance wildlife habitat or assist revegetation, and if they are not incompatible with the stability of the fill; and

Permanent impoundments are not planned on the excess spoil area. Small depressions may be constructed as allowed by the Division to retain moisture, minimize erosion, create and enhance wildlife habitat or assist revegetation.

745.113: Adequately cover or treat the excess spoil that is acid- and toxic forming with nonacid nontoxic material to control the impact on the surface and ground water in accordance with R645-301-731.300 and to minimize adverse effects on plant growth and approved postmining land use.

Laboratory data representative of the overburden planned for disposal in the excess spoil area does not show acid- and toxic forming characteristics.

745.120: Drainage Control. If the disposal area contains springs, natural or manmade water courses, or wet weather seeps, the fill design will include *diversions and underdrains as necessary to control erosion, prevent water infiltration into the fill and ensure stability.*

A spring and seep survey available in Chapter 7 has identified no springs or wet weather seeps in the proposed excess spoil area. The final surface will be regraded to a contour that will route water from snowmelt and rainfall around the excess spoil as shown on the final contours Drawing 5-35. There are no manmade water courses present in the excess spoil area. No underdrains are planned for the excess spoil structure.

745.121: Diversions will comply with the requirements of R645-301-742.300

No diversions are planned in the excess spoil area.

745.122 : Underdrains

No underdrains are planned in the excess spoil area.

745.300: Durable Rock Fills

No durable rock fills are planned.

745.400: Preexisting Benches

The MRP does not contemplate disposal of excess spoil on preexisting benches.

528.320. Coal Mine Waste.

The MRP does not contemplate processing coal that would produce coal mine waste.

528.322. Refuse Piles.

The MRP does not contemplate the construction of any refuse piles,

528.323. Burning and Burned Waste Utilization.

The MRP does not contemplate processing coal that would produce coal mine waste, eliminating the any potential for coal mine waste fires.

528.330. Noncoal Mine Waste.

Noncoal mine wastes including, but not limited to, grease, lubricants, paints, flammable liquids, garbage, abandoned mining machinery, lumber and other combustible materials generated during mining activities will be temporarily stored in appropriate containers and removed from the permit area and will be properly disposed of according to applicable State and Federal regulations.

528.332.

Final disposal of noncoal mine wastes will be in a State-approved solid waste disposal site not located within the permit area.

528.333.

At no time will any noncoal mine waste be deposited in a refuse pile or impounding structure, nor will any excavation for a noncoal mine waste disposal site be located within eight feet of any coal outcrop or coal storage area.

528.334.

Notwithstanding any other provision to the R645 Rules, any noncoal mine waste defined as "hazardous" under 3001 of the Resource Conservation and Recovery Act (RCRA) (Pub. L. 94-580, as amended) and 40 CFR Part 261 will be handled in accordance with the requirements of Subtitle C of RCRA and any implementing regulations.

528.350. Acid-Forming and Toxic Materials

Debris, acid-forming, toxic-forming materials and materials constituting a fire hazard will be identified and disposed of in accordance with R645-301-528.330, R645-301-537.200, R645-301-542.740, R645-301-553.100 through R645-301-553.600, R645-301-553.900, and R645-301-747. Appropriate measures will be implemented to preclude sustained combustion of such materials; and

528.400. Dams, embankments and other impoundments.

Plans do not include using dams, embankments or other impoundments for disposal of coal, overburden, excess spoil or coal mine waste

529. **MANAGEMENT OF MINE OPENINGS.**

All wells will be managed to comply with R645-301-748 and R645-301-765. Water monitoring wells will be managed on a temporary basis according to R645-301-738.

Wells constructed for monitoring groundwater conditions in the proposed Coal Hollow Mine permit and adjacent area, including exploration holes and boreholes used for water wells or monitoring wells, will be designed to prevent contamination of groundwater and surface-water resources and to protect the hydrologic balance. A diagram depicting typical monitoring well construction methods is shown in Drawing 7-11. Monitoring wells will include a protective hydraulic seal immediately above the screened interval, an annular seal plugging the borehole above the hydraulic seal to near the ground surface, and a concrete surface seal extending from the top of the hydraulic seal to the ground surface which is sloped away from the well casing to prevent the entrance of surface flows into the borehole area. Well casings will protrude above the ground surface a sufficient height so as to minimize the potential for the entrance of surface water or other material into the well. A steel surface protector with a locking cover will be installed at monitoring wells to prevent access by unauthorized personnel. Where there is potential for damage to monitoring wells, the wells will be protected through the use of barricades, fences, or other protective devices. These protective devices will be periodically inspected and maintained in good operating conditions. Monitoring wells will be locked in a closed position between uses.

When no longer needed for monitoring or other use approved by the Division upon a finding of no adverse environmental or health and safety effects, or unless approved for transfer as a water well under R645-301-731.100 through R645-301-731.522 and R645-301-731.800, each well will be capped, sealed, backfilled, or otherwise properly managed, as required by the Division in accordance with R645-301-529.400, R645-301-631.100, and R645-301-748. Permanent closure measures will be designed to prevent access to the mine workings by people, livestock, fish and wildlife, machinery and to keep acid or other toxic drainage from entering ground or surface waters.

If a water well is exposed by coal mining and reclamation operations, it will be permanently closed unless otherwise managed in a manner approved by the Division.

Permanent closure and abandonment of water wells greater than 30 feet in depth will be in accordance with the requirements of "Administrative Rules for Water Well Drillers", State of Utah, Division of Water Rights or other applicable state regulations. Abandonment of wells will be performed by a licensed water well driller. The wells to be abandoned will be completely filled using neat cement grout, sand cement grout, unhydrated bentonite, or bentonite grout, or other materials approved by the Utah State Engineer's office. Alternatively, the well may be abandoned using a different procedure upon approval from the Utah State Engineer's office.

Abandonment materials will be introduced at the bottom of the well or required sealing interval and placed progressively upward to the top of the well. The casing will be severed a minimum of 2 feet below the ground surface. A minimum of 2 feet of compacted native material will be placed above the abandoned well upon completion.

Within 30 days of the completion of well abandonment procedures, a report will be submitted to the State Engineer by the responsible licensed driller giving data related to the abandonment of the well. This shall include the name of the licensed driller or other person(s) performing abandonment procedures, name of well owner at the time of abandonment, the address or location of the well by section, township, and range, abandonment materials and equipment used, water right or file number covering the well, the final disposition of the well, and the date of completion.

Exploration holes and boreholes will be backfilled, plugged, cased, capped, sealed, or otherwise managed to prevent acid or toxic contamination of water resources and to minimize disturbance to the prevailing hydrologic balance. Exploration holes and boreholes will be managed to ensure the safety of people, livestock, fish and wildlife, and machinery.

If a water well is exposed by coal mining and reclamation operations, it will be permanently closed unless otherwise managed in a manner approved by the Division.

If any exploration boreholes are to be used as monitoring wells or water wells, these will meet the provisions of R645-301-731

Boreholes will be backfilled to within 1 foot of the land surface with concrete or other materials approved by the Division as necessary to prevent contamination of groundwater or surface-water resources or to protect the prevailing hydrologic balance. The upper approximately 1 foot will be backfilled with native materials to facilitate reclamation (see Drawing 6-11). Exploration holes and boreholes that may be uncovered during mining and reclamation activities will be permanently closed unless approved for water monitoring or otherwise managed in a manner approved by the Division.

530 **OPERATIONAL DESIGN CRITERIA AND PLANS:**

531 GENERAL:

There are five sediment impoundments proposed for the permit area. These structures will be constructed using a combination of dozers and backhoes. The structures have been designed to contain the required storm events as specified in Appendix 5-2. The structures will have sediment removed as necessary to ensure the required capacities. Details for these structures can be viewed on Drawings 5-25, 5-26 and 5-28 through 5-32. Calculations and supporting text can be viewed in Appendix 5-2.

There are no other coal processing waste banks, dams or embankments proposed within the permit area.

Underground mining has not occurred within the permit area.

532 SEDIMENT CONTROL:

Four diversion ditches along with five sediment impoundments are proposed for the permit area. In addition, miscellaneous controls such as silt fence and berms are also proposed for specific areas. The proposed locations for these structures are shown on Drawing 5-3. Details associated with these structures can be viewed on Drawings 5-25 through 5-34 and Appendix 5-2.

Mulch will be placed on the seedbed surface once soil amendments have been incorporated and seeding has been accomplished in areas that will be reclaimed to native plant communities. The mulch should control erosion by wind and water, decrease evaporation and seed predation, and increase survivability of the seeded species. Like the seeding methods, mulch will be applied with a variety of techniques and materials depending on the reclaimed area.

532.100 Disturbed Area:

The smallest practicable area, consistent with reasonable and safe mine operational practices will be disturbed at any one time during the mining operation and reclamation phases. This will be accomplished through progressive backfilling, grading, and prompt revegetation of disturbed areas. An estimated reclamation schedule is shown on Drawing 5-38.

532.200 Backfill Stabilization:

The backfilled material will be stabilized by grading to promote a reduction of the rate and volume of runoff in accordance with the applicable requirements. The excess spoil and fill above approximate original contour will be graded to a maximum angle 3h:1v slope and revegetated to minimize erosion. This area is designed with concave slopes and slope irregularities that will also assist in minimizing erosion. A geotechnical analysis of this configuration has been completed and the factor of safety is estimated at 1.6 to 1.7. This analysis can be viewed in Appendix A5-1. The remaining backfill will be placed in the mined out pit, and thus confined on all sides. The backfill will be inherently stable.

Mulch will be placed on the seedbed surface once soil amendments have been incorporated and seeding has been accomplished in areas that will be reclaimed to native plant communities. The mulch should control erosion by wind and water, decrease evaporation and seed predation, and increase survivability of the seeded species. Like the seeding methods, mulch will be applied with a variety of techniques and materials depending on the reclaimed area.

533. IMPOUNDMENTS.

533.100.

No impoundments meeting the NRCS Class B or C criteria for dams in TR-60, or the size or other criteria of 30 CFR Sec. 77.216(a) are planned for the Coal Hollow Mine.

533.110

Impoundments not included in 533.100, will be designed and constructed with a minimum static safety factor of 1.3 for a normal pool with steady state seepage saturation conditions or meet the requirements of R645-301-733.210.

The proposed sediment impoundments are expected to impound seasonal water and storms. A geotechnical analysis of these designs has been performed and can be reviewed in Appendix 5-1. Static safety factors for the proposed designs range from 2.2 to 5.3.

533.200. Foundations.

Foundations for temporary and permanent impoundments will be designed so that

- *Foundations and abutments for the impounding structure are stable during all phases of construction and operation. Such foundations for temporary and permanent impoundments will be designed based on adequate and accurate information on the foundation conditions*

  Refer to Appendix 5-1 for information related to foundations of the proposed impounding structures. No permanent impoundments are proposed.

- *All vegetative and organic materials will be removed and foundations excavated and prepared to resist failure. Cutoff trenches will be installed if necessary to ensure stability.*

  All vegetation, topsoil and subsoil as identified in Chapter 2 will be removed from the impoundment areas prior to construction. Cutoff trenches will not be necessary for stability.

- *Slope protection will be provided to protect against surface erosion at the site and protect against sudden drawdown.*

  Slopes of impoundments will be seeded and sloped to protect against erosion at the site. The high clay content and compaction characteristics of the material present at the impoundments will also assist with minimizing erosion of the slopes.

- *Faces of embankments and surrounding areas will be vegetated except that faces where water is impounded may be riprapped or otherwise stabilized in accordance with accepted design practices.*

  Faces of embankments will be vegetated to minimize erosion. Standing water in the ponds is expected to be minimal and therefore these faces will also be seeded for erosion control.

- *The vertical portion of any remaining highwall will be located far enough below the low- water line along the full extent of highwall to provide adequate safety and access for the proposed water users.*

  All highwalls will be fully covered following active use and backfilling of pits.

533.300

A rapid drawdown analysis was completed assuming the spillways are plugged, the basin fills to top of the embankments and then the water is released or pumped down to the base of basins. The soil strengths utilized were based on total stress conditions as determined from the triaxial shear tests completed for this project. It should be noted that rapid drawdown is highly unlikely since spillway and outlet piping will be no more than 4-feet below the top of embankments. The resulting safety factors under these conditions range from 1.2 to 1.9. Based on this analysis, no additional protection measures are needed for the impoundments in relation to rapid drawdown. Details for this analysis are provided in Appendix 5-1, pages 6 through 7 in the main section of the report.

533.600.

The MRP does not contemplate construction of impoundments that meet the criteria of MSHA, 30 CFR 77.216(a).

533.700 - 714. Plans.

Each detailed design plan for structures not included in 533.610 shall:

- *Be prepared by, or under the direction of, and certified by a qualified, registered, professional engineer, except that all coal processing waste dams and embankments covered by R645-301-536 and R645-301- 746.200 shall be certified by a qualified, registered, professional engineer;*

  Designs for the proposed impoundments have been prepared by a qualified, registered, professional engineer, with assistance from a geotechnical expert. These certifications can be viewed on Drawings 5-28 through 5-31.

- *Include any design and construction requirements for the structure, including any required geotechnical information;*

  A geotechnical analysis of the impoundments has been prepared by an expert in this field. This analysis can be viewed in Appendix 5-1. Embankments will be constructed in 2 foot lifts as recommended by the analysis.

- *Describe the operation and maintenance requirements for each structure; and*

  The proposed impoundments are designed to temporarily store water from storm events and snow melt. Long term standing water in the impoundments is anticipated to be seasonal and sediment will be removed as necessary to provide the required storage capacities. Emergency spillways have been included in the designs to provide a non-destructive discharge route should the capacities ever be exceeded. Surveys of these impoundments will be regularly conducted to ensure that design capacities are available.

- *Describe the timetable and plans to remove each structure, if appropriate.*

  All impoundments will be reclaimed at the end of operations. The estimated timeline for removal of these structures are shown on Drawing 5-38. Expected removal is year four of the mining and reclamation process. In areas where soils are not stabilized following the removal of these sediment impoundments, silt fence will be appropriately installed and maintained to provide sediment control until stable conditions are met.

Detailed designs of impoundments can be viewed on Drawings 5-28 through 5-31. Locations can be viewed on Drawing 5-3 and 5-25.

534. **ROADS**

534.100-200 <u>Roads will be located, designed, constructed, reconstructed, used, maintained, and reclaimed so as to:</u>

- *Prevent or control damage to public or private property;*

  All roads will be reclaimed to approximate original contour as shown on Drawings 5-35, 5-36 and 5-38. These roads are designed to control damage to public and private property.

- *Use nonacid - or nontoxic-forming substances in road surfacing; and*

  There will be no acid or toxic forming substances used in road surfacing.

- *Have, at a minimum, a static safety factor of 1.3 for all embankments.*

  All embankments are designed with static safety factors that exceed 1.3.

- *Have a schedule and plan to remove and reclaim each road that would not be retained under an approved postmining land use.*

  All roads not planned to remain postmining will be removed and reclaimed according to Drawings 5-35 and 5-36. The estimated timetable for removing these roads is shown on Drawing 5-38.

- *Control or prevent erosion, siltation and the air pollution attendant to erosion by vegetating or otherwise stabilizing all exposed surfaces in accordance with current, prudent engineering practices.*

  Cut ditches will be established on the shoulders of all primary roads to control drainage and erosion. Cut and fill slopes along the primary roads will be minimal and are not expected to cause significant erosion. In locations where there are culvert crossings (i.e. Lower Robinson Creek), the fills slopes will be stabilized by utilizing standard methods such as grass matting or straw wattles.

- *To ensure environmental protection and safety appropriate for their planned duration and use, including consideration of the type and size of equipment used, the design and reconstruction of roads will incorporate appropriate limits for grade, width, surface materials, and any necessary design criteria established by the Division.*

The following specifications apply to the Primary Mine Haul roads:

1) Roads will be approximately 80' in width
2) Approximately a 2% crown
3) Approximately one foot deep cut ditches along shoulders for controlling storm water
4) 18" of crushed rock or gravel for road surfacing
5) Cut and fill slopes of 1.5 h:1v

6) Minimum fill over each culvert will be 2 times diameter of culvert
7) Berms placed as necessary along fills

The ancillary roads will have similar specifications except surfacing will occur only as needed and may be narrowed to a 40 foot road width. A typical cross section for the ancillary roads can be viewed on Drawing 5-24.

The location and details for Primary Mine Haul roads can be viewed on Drawings 5-3 and 5-22 and 5-23.

In addition to the two roads primary Mine Haul roads, the road located within the facilities area is also classified as a primary road. This road is planned to be 24 feet wide with 24 inches of compacted sub base and 8 inches of compacted 1 inch minus gravel as surfacing. This road is referred to as "Facilities Roadway" and more details are described in 527.200 along with Drawings 5-22A and 5-22B.

In addition to the primary roads that will be present during active mining, four additional roads are planned to exist postmining and are also classified as primary roads for this reason.

Roads that will remain postmining are the following:

- Road to Water Well with details shown on Drawing 5-22D
- Road to east C. Burton Pugh property with details shown on Drawing 5-22C
- County Road 136 (K3900) with details on Drawing 5-22E, 5-22F and 5-22G. This County road will be reconstructed within the permit area by Kane County. This reconstruction will occur concurrently with the final stage of reclamation as scheduled on Drawing 5-38 and is expected to be completed by the end of Year 4.
- Road to Swapp Ranch (same specification as the Water Well Road)

The location of these roads is shown on Drawings 5-35 and 5-37 along with the post mining topography.

The ramps, benches and equipment travel paths within the active surface mining area are temporary in nature and will be relocated frequently as mining progresses. These temporary travelways are considered part of the pit due to their short term use, and are not individually designed nor engineered. They will be built and maintained to facilitate safe and efficient mine and reclamation operations.

534.300-340. <u>Primary Roads</u>.

Primary roads will:

- *Be located, insofar as practical, on the most stable available surfaces;*

  These roads are designed on the most practicable, stable surfaces.

- *Be surfaced with rock, crushed gravel, asphalt, or other material approved by the Division as being sufficiently durable for the anticipated volume of traffic and the weight and speed of vehicles using the road;*

  Primary roads will be surfaced with approximately 18" of crushed rock or gravel to provide a durable surface for the anticipated volume of traffic and equipment.

- *Be routinely maintained to include repairs to the road surface, blading, filling potholes and adding replacement gravel or asphalt. It will also include revegetation, brush removal, and minor reconstruction of road segments as necessary; and*

  All roads will be maintained on an as needed basis using motor graders, water trucks for dust suppression, and other equipment as necessary. Crushed stone and/or gravel will be used as a surface course for primary roads outside the active mining area, and may be used as needed for ramps and travelways within the pit. Should the roads be damaged by a catastrophic event, such as an earthquake or a flood, repairs will be made as soon as possible after the damage has occurred or the road will be closed and reclaimed. Roads will be reclaimed once they are no longer needed for their intended use.

- *Have culverts that are designed, installed, and maintained to sustain the vertical soil pressure, the passive resistance of the foundation, and the weight of vehicles using the road.*

  Road fill over culverts will be at minimum two times the diameter of the culvert. This is a conservative standard that has been effectively utilized at mining operations with similar equipment and mining practices.

535. **SPOIL**

535.100 -150 Disposal of Excess Spoil. *Excess spoil will be placed in designated disposal areas within the permit area in a controlled manner. The fill and appurtent structures will be designed using current, prudent engineering practices and will meet any design criteria established by the Division.*

- *The fill will be designed to attain a minimum long-term static safety factor of 1.5. The foundation and abutments of the fill must be stable under all conditions of construction.*

  A geotechnical analysis has been completed for the proposed excess spoil structure. This analysis estimates the long-term safety factor to be 1.6 to 1.7 based on the proposed design. Following proper construction practices of building the structure in maximum four foot lifts and meeting 85% compaction based on the standard Procter will ensure that the structure will be stable under all conditions of construction. This construction will occur only in the designated excess spoil area as shown on Drawing 5-3 and 5-35. The fill will be placed with end dump haul trucks and lifts will be constructed using dozers. High precision

GPS systems will be regularly utilized to check grades and appropriate lift thickness. The geotechnical analysis for this structure can be viewed in Appendix 5-1.

- *Be located on the most moderately sloping and naturally stable areas available, as approved by the Division, and placed, where possible, upon or above a natural terrace, bench or berm, if such placement provides additional stability and prevents mass movement;*

The excess spoil is planned to be placed in an area where natural grades range from 0 to 5%. This is one of the most moderately sloping locations in the Permit Area. Stability of this structure is estimated to be 1.6 to 1.7 based on the Appendix 5-1.

- *Be subject of sufficient foundation investigations. Any necessary laboratory testing of foundation material, will be performed in order to determine the design requirements for foundation stability. The analyses of foundation conditions will take into consideration the effect of underground mine workings, if any, upon the stability of the fill and appurtent structures; and*

Geotechnical borings were completed in the foundation of the proposed disposal area. Laboratory analysis of these borings has also been completed. Details of this analysis can be viewed in Appendix 5-1.

- *Incorporate keyway cuts (excavations to bedrock) or rock buttresses to ensure stability where the slope in the disposal area is in excess of 2.8h:1v (36 percent), or such lesser slope as may be designated by the Division based on local conditions. Where the toe of the spoil rests on a downslope, stability analyses will be performed in accordance with R645-301-535.150 to determine the size of rock toe buttresses and keyway cuts*

Permanent slopes for the proposed excess spoil will not exceed 3h:1v (33 percent), therefore no keyway cuts have been proposed in the design. Appendix 5-1 details the stability analysis for the proposed structure.

- *Excess spoil may be disposed of in underground mine workings,..*

Excess spoil will not be disposed of in underground mine workings.

- *Placement of Excess Spoil. Excess spoil will be transported and placed in a controlled manner in horizontal lifts not exceeding four feet in thickness; concurrently compacted as necessary to ensure mass stability and to prevent mass movement during and after construction; graded so that surface and subsurface drainage is compatible with the natural surroundings: and covered with topsoil or substitute material in accordance with R645-301-232.100 through R645-301-232.600, R645-301-234, R645-301-242, and R645-301-243. The Division may* *approve a design which incorporates placement of excess spoil in horizontal lifts other than four feet in thickness when it is demonstrated by the operator and certified by a professional engineer that the design will ensure the stability of the fill and will meet all other applicable requirements.*

Horizontal lifts will not exceed four feet in thickness unless otherwise approved by the Division. The lifts will be concurrently compacted to meet 85% of the standard Procter. The geotechnical analysis (Appendix 5-1), provides information showing that these construction standards will provide mass stability and will prevent mass movement during and after construction. The excess spoil will be graded to provide drainage similar to original flow patterns. Topsoil and subsoil as designated in Chapter 2 will be removed and separated from other materials prior to placement of spoil.

- *For the purposes of SURFACE COAL MINING AND RECLMATION ACTIVITIES the design of the spoil disposal structures will include the results of geotechnical investigations as follows:*

1) *The Character of the bedrock and any adverse geologic conditions in the disposal area;*

   Refer to Appendix 5-1.

2) *A survey identifying all springs, seepage, and ground water flow observed or anticipated during wet periods in the area of the disposal site;*

   Spring and seep survey information is provided on Drawing 7-1. There are no springs or seeps identified in the excess spoil area.

3) *A survey of the potential effects of subsidence of the subsurface strata due to past and future mining operations;*

   There no historical underground mining operations in the proposed excess spoil area. There are also no future underground operations proposed.

4) *A technical description of the rock material to be utilized in the construction of those disposal structures containing rock chimney cores or underlain by a rock drainage blanket; and*

   There are no rock chimneys or drainage blankets proposed.

5) *A stability analysis including, but not limited to, strength parameters, pore pressures and long-term seepage conditions. These data will be accompanied by a description of all engineering design assumptions and calculations and the alternative considered in selecting the specific design specifications and methods.*

The stability analysis and all supporting data are available in Appendix 5-1.

- *If for the purposes of SURFACE COAL MINING AND RECLAMATION ACTIVITIES, under R645-301-535.112 and R645-301-535.113, rock-toe buttresses or key-way cuts are required, the will include the following:*

  Neither rock-toe buttresses or key-way cuts are required under R645-301-535.112 or R645-301-535.113.

535.200. Disposal of Excess Spoil: Valley Fills/Head-of-Hollow Fills.

The MRP does not contemplate disposal of excess spoil as valley fill or head-of-hollow fills.

535.300. Disposal of Excess Spoil: Durable Rock Fills.

The MRP does not contemplate disposal of excess spoil as durable rock fill.

535.400. Disposal of Excess Spoil: Preexisting Benches.

The MRP does not contemplate disposal of excess spoil on preexisting benches.

536. Coal Mine Waste.

The MRP does not contemplate processing of coal that would produce coal mine waste.

537 REGRADED SLOPES:

537.100 Geotechnical Analysis:

The excess spoil structure and fill above approximate original contour are the only alternative specifications proposed. A geotechnical analysis has been completed for this proposal and can be viewed in Appendix 5-1. All other mined areas will be restored to approximate original contour.

540 RECLAMATION PLAN:

541.100 - 400 General

When coal mining is completed, all pits will be backfilled and reclaimed in accordance with the R645 rules and this permit. All equipment, structures, and other facilities, unless approved by the Division as suitable for the postmining land use or environmental monitoring, will be removed and the affected land reclaimed.

When no longer needed for monitoring or other use approved by the Division upon a finding of no adverse environmental or health and safety effects, or unless approved for transfer as a water well under R645-301-731.100 through R645-301-731.522 and R645-301-731.800, each well will be capped, sealed, backfilled, or otherwise properly managed, as required by the Division in accordance with R645-301-529.400, R645-301-631.100, and R645-301-748. Permanent closure measures will be designed to prevent access to the mine workings by people, livestock, fish and wildlife, machinery and to keep acid or other toxic drainage from entering ground or surface waters.

If a water well is exposed by coal mining and reclamation operations, it will be permanently closed unless otherwise managed in a manner approved by the Division.

Permanent closure and abandonment of water wells greater than 30 feet in depth will be in accordance with the requirements of "Administrative Rules for Water Well Drillers", State of Utah, Division of Water Rights or other applicable state regulations. Abandonment of wells will be performed by a licensed water well driller. The wells to be abandoned will be completely filled using neat cement grout, sand cement grout, unhydrated bentonite, or bentonite grout, or other materials approved by the Utah State Engineer's office. Alternatively, the well may be abandoned using a different procedure upon approval from the Utah State Engineer's office.

Abandonment materials will be introduced at the bottom of the well or required sealing interval and placed progressively upward to the top of the well. The casing will be severed a minimum of 2 feet below the ground surface. A minimum of 2 feet of compacted native material will be placed above the abandoned well upon completion.

Within 30 days of the completion of well abandonment procedures, a report will be submitted to the State Engineer by the responsible licensed driller giving data related to the abandonment of the well. This shall include the name of the licensed driller or other person(s) performing abandonment procedures, name of well owner at the time of abandonment, the address or location of the well by section, township, and range, abandonment materials and equipment used, water right or file number covering the well, the final disposition of the well, and the date of completion.

Exploration holes and boreholes will be backfilled, plugged, cased, capped, sealed, or otherwise managed to prevent acid or toxic contamination of water resources and to minimize disturbance to the prevailing hydrologic balance. Exploration holes and boreholes will be managed to ensure the safety of people, livestock, fish and wildlife, and machinery.

If a water well is exposed by coal mining and reclamation operations, it will be permanently closed unless otherwise managed in a manner approved by the Division.

If any exploration boreholes are to be used as monitoring wells or water wells, these will meet the provisions of R645-301-731

Boreholes will be backfilled to within 1 foot of the land surface with concrete or other materials approved by the Division as necessary to prevent contamination of groundwater or surface-water resources or to protect the prevailing hydrologic balance. The upper approximately 1 foot will be backfilled with native materials to facilitate reclamation (see Drawing 6-11). Exploration holes and boreholes that may be uncovered during mining and reclamation activities will be permanently closed unless approved for water monitoring or otherwise managed in a manner approved by the Division.

542 NARRATIVE, DRAWINGS AND PLANS:

542-100 through 600 Plan and Timetable.

Reclamation at the Coal Hollow Mine includes both ongoing reclamation and final reclamation activities. Ongoing reclamation will follow mining operations as closely as practicable during the mine production phase. Major steps in the ongoing reclamation process are:

- Backfilling and Grading. The planned backfilling and grading operations are described more fully under section 553 below.
- Topsoil and Subsoil Replacement. Following grading, suitable topsoil and subsoil will be replaced on the regraded area. Topsoil may be direct placed from areas ahead of the mine, or may be taken from available stockpiled material. The planned topsoil operation will have topsoil ahead of the operation dozed into windrows, and loaded into trucks by a front end loader. The trucks will haul the topsoil to the regraded area, or to a temporary topsoil stockpile. Subsoil will be handled similar to topsoil. Once dumped on the regraded area, topsoil and subsoil layers will be dozed to a consistent thickness. Approximately 8 inches of topsoil is expected to be removed ahead of mining and replaced over the regraded area. Subsoil removed and replaced will average 40 inches thick and will be placed between the topsoil layer and run of mine spoil. The total profile thickness of topsoil and subsoil in mined areas will average 48 inches. Once in place, the area will be fine graded to remove small erosion features and depressions.
- Revegetation. Following replacement of topsoil the area will be revegetated by seeding. Mulch will be placed on the seedbed surface once soil amendments have been incorporated and seeding has been accomplished in areas that will be reclaimed to native plant communities. The mulch should control erosion by wind and water, decrease evaporation and seed predation, and increase survivability of the seeded species. Like the seeding methods, mulch will be applied with a variety of techniques and materials depending on the reclaimed area.

Generally, mined areas will be backfilled and graded within approximately 180 days following coal removal, or 1,500 feet of the active coal removal face. One exception to this standard is during mining and backfilling of the final pits in the south end of the permit area. During this phase of mining, backfilling will follow approximately 2,000 feet from the active coal face. A detailed description of the reason for this variation are fully described in section 528 (Overburden) and the major steps can be viewed on Drawings 5-17 through 5-19. Areas needed for in-pit roads, ramps, drainage controls or areas which must be left open temporarily for operational reasons will be backfilled and graded when they are no longer needed. The rate of backfilling will depend on the availability of mined out pit areas for backfilling, and the rate of production at the mine. Based on anticipated production rates, Drawing 5-38 provides an estimated sequence and timing for reclamation.

Topsoil will be replaced on the graded areas as soon as operationally practicable. This work will depend on weather and soil conditions in the removal and replacement areas, but is generally anticipated to occur within 90 days of completion of regrading.

Revegetation activities will be seasonal in nature. As currently planned, initial seeding will occur at the first planting opportunity following replacement of topsoil. Supplemental seeding may be done subsequently as needed.

Some delay is unavoidable in reclamation of the initial mining areas due to the time required to establish the initial working pit and backfill area, and to achieve a steady state excavation/backfill operation. As currently planned the initial mining areas will be backfilled to the planned post mining contour, graded, and the topsoil replaced by late in the first year or in the first half of the second year of mining. Reclamation activities will proceed at the regular planned rate thereafter. Proposed final reclamation contours and cross sections can be viewed on Drawings 5-35 and 5-36.

The sequence and timing of reclamation activities is dependent on the coal production rate. Should that rate differ significantly from the current plan, the reclamation schedule will also vary.

Final reclamation includes the following:

- Backfilling and Grading. Backfilling of all final pits will commence at the conclusion of coal production. All highwalls, spoil piles, and depressions will be removed, except that small depressions may be constructed if they are needed to retain moisture, minimize erosion, create and enhance wildlife habitat, or assist revegetation. No permanent final pit impoundments are currently planned. The excess spoil structure will remain. All exposed coal seams, and acidic or toxic-forming strata will be covered with at least five feet of noncombustible material.
- Topsoil and Subsoil Replacement. 8 inches of topsoil underlain by 40 inches of subsoil will be placed on the backfilled pits and excess spoil. Other disturbed areas will have topsoil replaced (including facilities sites, roads etc.).
- Removal of Structures. Before abandoning the permit area or seeking bond release, all structures not needed for the approved post mining land use will be removed and reclaimed. The Lower Robinson Creek diversion is proposed to be

temporary. Material from the coal stockpile base area and other areas where coal spillage may accumulate will be excavated and placed in a controlled manner in the final pit and covered with noncombustible material to prevent sustained combustion. The only structure planned to exist postmining is the water well with details shown in Drawing 5-8C and location shown on 5-3, 5-35 and 5-37.

- Removal of Roads. Roads not retained for use under an approved postmining land use will be reclaimed immediately after they are no longer needed for mining and reclamation operations. Roads that are not listed as postmining roads in this section, will be closed to traffic; and all bridges and culverts removed. Prior to reclamation, surface material that is incompatible with the postmining land use and revegetation requirements will be removed from the roads and properly disposed of at the mine site. The roadbeds will be scarified or ripped to break up the surface. Topsoil will be replaced on the roadbed and the surface revegetated in accordance with the standards set forth in R645.

  Roads that will remain postmining are the following:
  - Road to Water Well with details shown on Drawing 5-22D
  - Road to east C. Burton Pugh property with details shown on Drawing 5-22C
  - County Road 136 (K3900) with details on Drawing 5-22E, 5-22F and 5-22G. This County road will be reconstructed within the permit area by Kane County. This reconstruction will occur concurrently with the final stage of reclamation as scheduled on Drawing 5-38 and is expected to be completed by the end of Year 4.
  - Road to Swapp Ranch (same specification as the Water Well Road)

  The location of these roads is shown on Drawings 5-35 and 5-37 along with the post mining topography.

- Removal of Water Control Structures. All sedimentation control structures, including ditches, berms and sedimentation ponds not retained as part of the approved post-mining land use will be removed, the areas regraded, topsoiled, and revegetated. All water control structures will be removed at final reclamation.

Final pit backfilling, removal of buildings, roads and other facilities, along with replacement of topsoil is expected to require approximately 15 months after the last coal is removed. In the alternate reclamation scenario (Drawing 5-37), the bulk of this period will be required to backfill the final pits.

542.700. Final Abandonment of Mine Openings and Disposal Areas.

When no longer needed for monitoring or other use approved by the Division upon a finding of no adverse environmental or health and safety effects, or unless approved for transfer as a water well under R645-301-731.100 through R645-301-731.522 and R645-301-731.800, each well will be capped, sealed, backfilled, or otherwise properly managed, as required by the Division in accordance with R645-301-529.400, R645-301-631.100, and R645-301-748. Permanent closure measures will be designed to prevent access to the mine workings by people, livestock, fish and wildlife, machinery and to keep acid or other toxic drainage from entering ground or surface waters.

If a water well is exposed by coal mining and reclamation operations, it will be permanently closed unless otherwise managed in a manner approved by the Division.

Permanent closure and abandonment of water wells greater than 30 feet in depth will be in accordance with the requirements of "Administrative Rules for Water Well Drillers", State of Utah, Division of Water Rights or other applicable state regulations. Abandonment of wells will be performed by a licensed water well driller. The wells to be abandoned will be completely filled using neat cement grout, sand cement grout, unhydrated bentonite, or bentonite grout, or other materials approved by the Utah State Engineer's office. Alternatively, the well may be abandoned using a different procedure upon approval from the Utah State Engineer's office.

Abandonment materials will be introduced at the bottom of the well or required sealing interval and placed progressively upward to the top of the well. The casing will be severed a minimum of 2 feet below the ground surface. A minimum of 2 feet of compacted native material will be placed above the abandoned well upon completion.

Within 30 days of the completion of well abandonment procedures, a report will be submitted to the State Engineer by the responsible licensed driller giving data related to the abandonment of the well. This shall include the name of the licensed driller or other person(s) performing abandonment procedures, name of well owner at the time of abandonment, the address or location of the well by section, township, and range, abandonment materials and equipment used, water right or file number covering the well, the final disposition of the well, and the date of completion.

Exploration holes and boreholes will be backfilled, plugged, cased, capped, sealed, or otherwise managed to prevent acid or toxic contamination of water resources and to minimize disturbance to the prevailing hydrologic balance. Exploration holes and boreholes will be managed to ensure the safety of people, livestock, fish and wildlife, and machinery.

If a water well is exposed by coal mining and reclamation operations, it will be permanently closed unless otherwise managed in a manner approved by the Division.

If any exploration boreholes are to be used as monitoring wells or water wells, these will meet the provisions of R645-301-731

Boreholes will be backfilled to within 1 foot of the land surface with concrete or other materials approved by the Division as necessary to prevent contamination of groundwater or surface-water resources or to protect the prevailing hydrologic balance. The upper approximately 1 foot will be backfilled with native materials to facilitate reclamation (see Drawing 6-11). Exploration holes and boreholes that may be uncovered during mining and reclamation activities will be permanently closed unless approved for water monitoring or otherwise managed in a manner approved by the Division.

542.720. Disposal of Excess Spoil.

A geotechnical analysis has been completed for the proposed excess spoil structure. This analysis estimates the long-term safety factor to be 1.6 to 1.7 based on the proposed design. Following proper construction practices of building the structure in maximum four foot lifts and meeting 85% compaction based on the standard Procter will ensure that the structure will be stable under all conditions of construction. This construction will occur only in the designated excess spoil area as shown on Drawing 5-3 and 5-35. The fill will be placed with end dump haul trucks and lifts will be constructed using dozers. High precision GPS systems will be regularly utilized to check grades and appropriate lift thickness. The geotechnical analysis for this structure can be viewed in Appendix 5-1.

Excess spoil that is combustible will be adequately covered with noncombustible material to prevent sustained combustion.

542.730. Disposal of Coal Mine Waste.

The MRP does not contemplate processing of coal that would produce coal mine waste.

542.740. Disposal of Noncoal Mine Wastes.

Noncoal mine waste including, but not limited to grease, lubricants, paints, flammable liquids, garbage, abandoned mining machinery, lumber and other combustible materials generated during mining activities will be placed and temporarily stored in a controlled manner in a designated portion of the permit area and hauled offsite to a state approved recycling or solid waste disposal site. Final disposal of noncoal mine waste will not take place within the permit area.

542.800. Reclamation Cost.

The amount of the bond will depend upon the requirements of the ***approved*** permit and reclamation plan (R645-830.120).

A preliminary estimate of reclamation costs is included in Appendix 8-1. This estimate is based upon the proposed plan. A final bond estimate will be provided by the applicant to the Division upon completion of the approved permit and reclamation plan.

550. RECLAMATION DESIGN CRITERIA AND PLANS

551. SEALING AND CASING OF UNDERGROUND OPENINGS

When no longer needed for monitoring or other use approved by the Division upon a finding of no adverse environmental or health and safety effects, or unless approved for transfer as a water well under R645-301-731.100 through R645-301-731.522 and R645-301-731.800, each well will be capped, sealed, backfilled, or otherwise properly managed, as required by the Division in accordance with R645-301-529.400, R645-301-631.100, and R645-301-748. Permanent closure measures will be designed to prevent access to the mine workings by people, livestock, fish and wildlife, machinery and to keep acid or other toxic drainage from entering ground or surface waters.

If a water well is exposed by coal mining and reclamation operations, it will be permanently closed unless otherwise managed in a manner approved by the Division.

Permanent closure and abandonment of water wells greater than 30 feet in depth will be in accordance with the requirements of "Administrative Rules for Water Well Drillers", State of Utah, Division of Water Rights or other applicable state regulations. Abandonment of wells will be performed by a licensed water well driller. The wells to be abandoned will be completely filled using neat cement grout, sand cement grout, unhydrated bentonite, or bentonite grout, or other materials approved by the Utah State Engineer's office. Alternatively, the well may be abandoned using a different procedure upon approval from the Utah State Engineer's office.

Abandonment materials will be introduced at the bottom of the well or required sealing interval and placed progressively upward to the top of the well. The casing will be severed a minimum of 2 feet below the ground surface. A minimum of 2 feet of compacted native material will be placed above the abandoned well upon completion.

Within 30 days of the completion of well abandonment procedures, a report will be submitted to the State Engineer by the responsible licensed driller giving data related to the abandonment of the well. This shall include the name of the licensed driller or other person(s) performing abandonment procedures, name of well owner at the time of abandonment, the address or location of the well by section, township, and range, abandonment materials and equipment used, water right or file number covering the well, the final disposition of the well, and the date of completion.

Exploration holes and boreholes will be backfilled, plugged, cased, capped, sealed, or otherwise managed to prevent acid or toxic contamination of water resources and to minimize disturbance to the prevailing hydrologic balance. Exploration holes and boreholes will be managed to ensure the safety of people, livestock, fish and wildlife, and machinery.

If a water well is exposed by coal mining and reclamation operations, it will be permanently closed unless otherwise managed in a manner approved by the Division.

If any exploration boreholes are to be used as monitoring wells or water wells, these will meet the provisions of R645-301-731

Boreholes will be backfilled to within 1 foot of the land surface with concrete or other materials approved by the Division as necessary to prevent contamination of groundwater or surface-water resources or to protect the prevailing hydrologic balance. The upper approximately 1 foot will be backfilled with native materials to facilitate reclamation (see Drawing 6-11). Exploration holes and boreholes that may be uncovered during mining and reclamation activities will be permanently closed unless approved for water monitoring or otherwise managed in a manner approved by the Division.

552. **PERMANENT FEATURES.**

552.100

Small depressions may be constructed if they are needed to retain moisture, minimize erosion, create and enhance wildlife habitat, or assist revegetation.

552.200

All impoundments will be reclaimed, no permanent impoundments are proposed.

553 **BACKFILLING AND GRADING:**

Backfilling and Grading of the mined area will proceed in conjunction with coal recovery operations.

The planned mine will recover approximately 5.02 million tons of coal, and remove approximately 31.6 million Bank Cubic Yards (BCY) of overburden. The following is a description of the overburden removal and backfilling process:

Based on the overburden isopach map (Drawing 5-15), the overburden removal and backfilling process has been separated into three major stages. The first stage of this process is for the initial mining area, Pits 1-8. These pits have a relatively low strip ratio, approximately 5:1 (refer to Drawing 5-13). In order to efficiently remove overburden for this phase, spoil from the first three pits, including Pit 2 the boxcut, will be placed in an excess spoil area located immediately west of Pit 1. This excess spoil structure will hold approximately 2.7 million loose cubic yards (LCY) of material and is shown on Drawing 5-17. Once the excess spoil pile is filled, overburden from Pits 4 through 8 can then be used as pit backfill as the mining progresses through Pit 8. The completion of this phase is shown on Drawing 5-17.

As mining progresses through Pits 9-15, the isopach (Drawing 5-15) shows that the overburden significantly increases. This increase and the shape of the mining boundary for the Permit Area require a fill above approximate original contour that is an extension of the excess spoil pile. Material from Pits 9-15 significantly exceeds the backfill capacity available from the preceding pits (Pits 1-8). The fill above approximate original contour blends in with the excess spoil structure from Stage 1 and extends an additional 2,500 feet to the east as the mining sequence proceeds to Pit 15. In this stage, the fill above original contour is approximately 5.8 million LCY. Drawing 5-18 (Stage 2) shows the details of this stage of the overburden removal and resulting landform.

Stage 3 overburden removal begins in Pit 16 and proceeds through Pit 30. During this stage, the strip ratio reduces significantly from Stage 2 as mining progresses to the south end of the property. As the strip ratio reduces to the south, significant backfill capacity is available in the preceding Pit 15. This results in the distance between the backfill and the active coal face increasing because there is a lack of spoil in the lower ratio pits as mining proceeds south to fill the preceding higher ratio area. At the end of mining this phase, an area will not be completely backfilled that is approximately 2,000 feet in length and 1,300 feet wide and will require 6.8 million yards of fill to complete reclamation to approximate original contour. This remaining pit provides an open pit adjacent to the federal coal reserves for backfilling of overburden so that a smooth transition can be made without developing another boxcut and an excess spoil area. The backfill configuration at the end of this stage is shown in Drawing 5-19.

The proposed plan (Preferred Scenario) for backfilling the final pits is based on the assumption that Alton Coal Development, LLC will be successful with acquiring the adjacent federal coal reserves, located immediately to the west of the project area. This Preferred scenario for backfilling will minimize overall disturbance, and maximize resource recovery by providing a transition into the adjacent federal reserves with minimal effect to existing reclamation and backfill in the Permit Area. This scenario will also minimize variances from approximate original contour on the federal lands by eliminating the need for an excess spoil structure from the initial box cut as operations are transitioned into these reserves. In addition, this scenario provides a method for implementing concurrent reclamation during the project by eliminating temporary stockpiles of spoil that can not be reclaimed and have to be placed in backfilled areas at a later time. Use of temporary spoil stockpiles significantly delay reclamation and this plan eliminates the need for these type of temporary structures.

At the time that the transition occurs into the federal reserves, overburden will be removed from the federal reserves and placed in the final pits to approximate original contour. This final landform can be viewed on Drawings 5-35 and 5-36.

The following is an overburden and backfill balance for this scenario:

Preferred Scenario (Adjacent Federal Reserves Acquired)				
Phase	Overburden (LCY)	Available Backfill (LCY)	Excess Spoil (LCY)	Total Excess Spoil (LCY)
1	7,945,000	5,204,000	2,741,000	2,741,000
2	15,145,000	9,303,000	5,842,000	8,583,000
3	15,447,000	22,247,000	0	8,583,000
4 (Federal)	6,800,000	6,800,000	0	8,583,000
Total	45,337,000	36,754,000	8,583,000	8,583,000

*Loose Cubic Yards is estimated based on an overall 22% swell factor (Caterpillar Performance Handbook)

In the case that Alton Coal Development is not successful with acquiring the adjacent federal coal reserves, an alternate scenario has been developed. The Alternate scenario requires that all fill above approximate original contour and part of the excess spoil structure will be rehandled and placed in the remaining backfill area. The final landform for this scenario is shown on Drawing 5-37. This step requires rehandle of approximately 6.8 million yards of spoil. In this scenario, reclamation of the project area will be significantly delayed and the transition into adjacent federal coal reserves at a later date will disturb additional backfill along the west permit boundary approximately 2,000 feet in length by 230 feet wide (10 acres). An additional excess spoil structure would then need to be constructed on the federal lands to place spoil from the initial boxcut. Part of the excess spoil would likely be material removed from the Permit Area to access the coal beneath the Permit Area highwalls and provide the proper layback of the backfill material along the Permit boundary.

The following table summarizes the overburden and backfill balance for this scenario:

Alternate Scenario (Adjacent Federal Reserves Not Acquired)				
Phase	Overburden (LCY)	Available Backfill (LCY)	Excess Spoil (LCY)	Total Excess Spoil (LCY)
1	7,945,000	5,204,000	2,741,000	2,741,000
2	15,145,000	9,303,000	5,842,000	8,583,000
3	15,447,000	22,247,000	0	8,583,000
4 (Rehandle)	0	6,800,000	-6,800,000	1,783,000
Total	38,537,000	36,754,000	1,783,000	1,783,000

In both scenarios (Preferred and Alternate), Rough backfilling and grading operations will follow coal removal by not more than 60 days or 1500 linear feet except for the exemption in the south end of the mining area (Pits 24 through 30), which is described above in a step by step manner in the Stage 3 overburden removal process, the above tables and Drawings 5-17 through 5-19. This exemption is expected to take place in Year 3 of the mining process.

Major steps in the backfilling and grading process are:

- Backfilling of the Mined Out Pit. Material from active pits will be used to backfill mined out pits as mining progresses. Material will be placed in the in-pit backfill in lifts, until the approximate planned final elevation is reached. Working stability in the backfill will be achieved by placement of the material, and control of the overall spoil face slope at stable angles. The mined out area will be filled to its planned post-mining elevation, which approximates the pre-mining land contour. The backfill will be inherently stable because the exposed surface will have shallow slopes, and the backfill surface will not be significantly higher than the surrounding undisturbed ground with the exception of the variance shown on Drawing 5-3.

- Backfilling of Ramps. Ramps and travelways within the active mining will be moved as necessary for safe operation and efficient hauling of overburden and coal. When a particular ramp or travelway is no longer needed, it will be backfilled with excavated overburden from the advancing pit.
- Grading. After backfilling is complete in each mined out area, the area will be graded using dozers and motor graders to achieve the planned post-mining contour, facilitate stable positive drainage patterns, and to blend in with the surrounding topography. Postmining slopes will not exceed either the angle of repose or such lesser slope as is necessary to achieve a minimum long-term static safety factor of 1.3 and prevent slides. A geotechnical analysis has been completed for the excess spoil structure and can be found in Appendix 5-1.

Timing of backfilling and grading operations will depend on the rate of mine advance and the availability of backfill space and material. It is planned that mined areas will be backfilled and graded within approximately 180 days following coal removal, or 1,500 feet of the active coal removal face. As described in the previous text and shown on Drawing 5-19, there will be a variance from this standard in the final pits. Areas needed for in-pit roads, ramps, drainage controls or areas which must be left open temporarily for operational reasons will be backfilled and graded as they become available.

Some delay is unavoidable in backfilling the initial mining areas due to the time required to establish the initial working pit and backfill area, and to achieve a steady state excavation/backfill operation. As currently planned, the initial mining areas will be backfilled to the planned post mining contour, graded, and the topsoil replaced in late Year 1.

553.110

All areas except for the excess spoil pile and the variance from AOC (approximately 85 acres), will be restored to approximate original contour as shown on Drawing 5-35. R645-301-553.800 (Thick Overburden) does apply to this surface mine. In areas where excess spoil and variance from approximate original contour occur, the slopes will be regraded to a maximum angle of 3h:1v and most slopes are flatter as shown on Drawing 5-35 and 5-36. A geotechnical analysis has been completed to verify that the spoil material will be stable long term. This analysis can be viewed in Appendix 5-1.

553.120

All highwalls will be eliminated in the final landform. Small depressions may be constructed as needed to retain moisture, minimize erosion, create and enhance wildlife habitat or assist vegetation. All spoil piles will be eliminated with the exception of the planned excess spoil and variance from original contour as shown on Drawing 5-35.

553.130

Postmining slopes will not exceed the angle of repose which is expected to be approximately 1.5h:1v as described in Appendix 5-5. This appendix is an analysis by Dr. Ben Seegmiller addressing the safety factor for the post mining slope with the lowest safety factor outside the excess spoil area. This analysis concludes that a minimum safety factor of these slopes will be 1.7 which exceeds the requirement of 1.3. The excess spoil slopes have been analyzed by Alan Taylor, P.E., an expert in geotechnical engineering. These slopes also significantly exceed the required 1.3 safety factor. Details for this analysis by Mr. Taylor can be viewed in Appendix 5-1.

553.140

Slopes will be regraded and vegetated to minimize erosion and water pollution on and off the site.

553.150

Backfilling and grading will be conducted to support the approved postmining land use.

553.200 Spoil and Waste.

Spoil located in the excess spoil area and the variance from approximate original contour will be compacted to 85% of the standard Procter to provide long term stability of these structures. Remaining backfill in mined out areas will be confined and regraded to approximate original contour and will therefore not require compaction for long term stability. Subsoil will be placed over spoils and waste prior to placement of topsoil. This subsoil layer will provide a covering with minimal infiltration rate to prevent leaching of toxic materials.

553.210

Excess spoil from surface mining activities will be disposed of according to R645-301-211, R645-301-212, R645-301-412.300, R645-301-512.210, R645-528.310, R645-301-535.100 through R645-301-535.130, R645-301-535.300 through R645-301-535.500, R645-536.300, R645-301-542.720, R645-301-553.240, R645-301-745.100, R645-301-745.100, R645-301-745.300, and R645-301-745.400. Detail for meeting these standards can be reviewed in the corresponding sections.

553.220

The MRP does not contemplate placing spoil on areas outside the mined-out surface area for the purposes of restoring the approximate original contour.

553.300. Covering of Exposed Coal Seams, and Acid- and Toxic-Forming Materials.

Exposed coal seams, acid- and toxic-forming materials, and combustible materials exposed, used, or produced during mining will be adequately covered with nontoxic and noncombustible materials, or treated, to control the impact on surface and ground water in accordance with R645-301-731.100 through R645-301-731.522 and R645-301-731.800, to prevent sustained combustion, and to minimize adverse effects on plant growth and on the approved postmining land use.

553.400. Cut and Fill Terraces

The MRP does not contemplate constructing cut and fill terraces.

553.500. Previously Mined Areas (PMA's) and Continuously Mined Areas (CMA's).

The MRP does not contemplate operations associated with PMA's, CMA's, or areas with remaining highwalls.

553.600. Highwall Management

The MRP does not contemplate operations associated with PMA's, CMA's, or areas with remaining highwalls.

553.700. Backfilling and Grading: Thin Overburden.

The Coal Hollow project is expected to have approximately 1.8 million loose cubic yards of excess spoil; therefore R645-301-800 applies rather than R645-301-553.700.

553.800. Backfilling and Grading: Thick Overburden.

553.810

The spoil will be placed to attain the lowest practicable grade, and will not exceed the angle of repose for the material. A sequence of the steps for practicable movement of the excess spoil is shown on Drawings 5-17 through 5-19. The slopes on the excess spoil and variance from the approximate original contour will not exceed 3h:1v or flatter, which will provide a long-term, stable structure. The general design of the tall (60'+ vertically) excess spoil slopes is 5h:1v to 4h:1v to 3h:1v, bottom to top. This design creates a concave shape slope that resembles naturally occurring hills in the area and will minimize erosion. In addition, irregularities (flatter areas) have been added to break up long slopes. The overall shape of the pile is also irregular to be similar to hills in the surrounding area. The final configuration of this excess spoil can be viewed in Drawings 5-35 and 5-36. The angle of repose for the spoil material is expected to be 1.5h:1v as provided in Appendix 5-5 in the Introductory Overview (page 1) by Dr. Ben Seegmiller, an expert in the field of rock mechanics and slope stability. The design slopes are significantly flatter than the angle of repose expected for the spoil.

553.820 - 553.830

Backfilling and Grading of thick overburden will meet the following requirements:

- *R645-301-211: The applicant will present a description of the premining soil resources as specified under R645-301-221. Topsoil and subsoil to be saved under R645-301-232 will be separately removed and segregated from other material.*

  The soil resources for the proposed excess spoil disposal area are described in 2-1. A plan has been developed for removal of topsoil and suitable subsoil based on the soil descriptions in this appendices. The handling plan can be viewed on Drawing 2-2. Topsoil and acceptable subsoil will be separately removed and segregated from other material prior to placement of any spoil.

- *R645-301-212: After removal, topsoil will be immediately redistributed in accordance with R645-301-242, stockpiled pending redistribution under R645-301-234, or if demonstrated that an alternative procedure will provide equal or more protection for the topsoil, the Division may, on a case-by case basis, approve an alternative;*

  Excess spoil will have topsoil and subsoil redistributed in an approximately uniform, stable thickness with the approved post mining land use, contours and surface water drainage systems. Material handling practices will prevent excess compaction of these materials. Handling practices will also protect the materials from wind and water erosion before and after seeding and planting.

- *R645-301-412.300: Criteria for Alternative Postmining Land Uses.*

  Not Applicable

- *R645-301-512.210: Excess Spoil. The professional engineer experienced in the design of earth and rock fills will certify the design according to R645-301-535.100.*

  A professional engineer experienced in the design of earth and rock fills with assistance from a geotechnical expert has certified the design according to R645-301-535.100. These certifications can be viewed on Drawings 5-35, 5-36 and 5-17 through 5-19.

- *R645-301-512.220: Durable Rock Fills*

  No durable rock fills are planned.

- *R645-301-514.100: Excess Spoil. The professional engineer or specialist will be experienced in the construction of earth and rock fills and will periodically inspect the fill during construction. Regular inspections will also be conducted during placement and compaction of fill materials.*

  A professional engineer or specialist that is experienced in the construction of earth and rock fills will inspect the fill during construction and regular inspections will also be conducted during placement and compaction of fill materials.

- *R645-301-528.310: Excess spoil will be placed in designated disposal areas within the permit areas within the permit area, in a controllable manner to ensure mass stability and prevent mass movement during and after construction. Excess spoil will meet the design criteria of R645-301-535. For the purposes of SURFACE COAL MINING AND RECLAMATION ACTIVITIES, the permit application must include a description of the proposed disposal site and the design of the spoil disposal structures according to R645-301-211, R645-301-212, R645-301-412.300, R645-301-512.210, R645-528.310, R645-301-535.100 through R645-301-535.130, R645-301-535.300 through R645-301-535.500, R645-536.300, R645-301-542.720, R645-301-553.240, R645-301-745.100, R645-301-745.100, R645-301-745.300, and R645-301-745.400.*

  Excess spoil will be placed in the area designated on Drawing 5-3 and 5-35. This fill will be placed in lifts not to exceed 4 feet. The material will be transported from the overburden removal area to the fill by end dump haul trucks and a dozer(s) will spread the spoil to this lift thickness. The fill will meet at minimum 85% compaction as related to the standard Procter. Final slopes will be regraded to a maximum slope of 3h:1v. The top of the fill will sloped to approximately 2% to prevent pooling of water and to reestablish drainage similar to the original flow patterns. The excess spoil placed on the non-mined areas is approximately 32 acres and varies in height from 35 to 110 feet. The area of excess fill over mined out areas (variance from approximate original contour) is an extension of the fill placed on the non-mined area and is approximately 55 acres. Combined acreage of the excess fill placed on mined and non-mined areas is 87 acres and varies in height from 60 to 100 feet above original contour. Total excess fill is 8.6 million yards. Design of this fill can be viewed in Drawings 5-35 through 5-36 and the geotechnical study can be viewed in Appendix 5-1.

- *R645-301-535.100 through R645-301-130: Disposal of Excess Spoil*

  A geotechnical analysis of the excess spoil structure design has been completed by an expert in this field. The long term static safety factor for this structure design is estimated at 1.6 to 1.7. Lifts will be placed in thicknesses not to exceed 4 feet. The lifts will meet 85% compaction by the standard Procter. The fill will be graded to allow for drainage similar to original patterns and to prevent excessive infiltration of water. Fill will be covered with subsoil and topsoil as specified in Chapter 2 to provide conditions suitable for revegetation of the area. The geotechnical study can be viewed in Appendix A5-1.

- *R645-301-535.300 through R645-301-535.500: Disposal of Excess - Spoil Durable Rock Fills.*

  Not Applicable

- *R645-301-536.300: Disposal of Coal Mine Waste in Excess Spoil*

  No coal mine waste is planned in the excess spoil area.

- *R645-301-542.720: Excess spoil will be placed in designated disposal areas within the permit area, in a controlled manner to ensure that the final fill is suitable for reclamation and revegetation compatible with the natural surroundings and the approved postmining land use. Excess spoil that is combustible will be adequately covered with noncombustible material to prevent sustained combustion. The reclamation of excess spoil will comply with the design criteria under R645-301-553.240.*

  The excess spoil as shown in Drawing 5-35 and 5-36 will be suitable to the surrounding area and for the postmining land use of primarily grazing. No combustible excess spoil will be placed in the proposed structure. The reclamation of the spoil does not include any terraces and the slopes will not exceed 3h:1v.

- *R645-301-553.240: The final fill configuration of the fill (excess spoil) will be suitable for the approved postmining land use. Terraces may be constructed on the outslope of the fill if required for stability, control of erosion, to conserve soil moisture, or to facilitate the approved postmining land use. The grade of the outslope between terrace benches will not be steeper than 2h:1v (50 percent).*

  The excess spoil as shown in Drawings 5-35 and 5-36 will be suitable to the surrounding area and for the postmining land use of primarily grazing. The reclamation of the spoil does not include any terraces and the slopes will not exceed 3h:1v. This slope angle has been utilized at similar mining operations and found to be suitable for erosion control and revegetation of reclaim slopes. The long term static safety factor for these slopes is estimated to be 1.6 to 1.7.

- *R645-301-745.100: General Requirements.*

  745.110: Excess Spoil will be placed in designated disposal areas within the permit area, in a controlled manner to:

745.111: Minimize the adverse effects of leaching and surface water runoff from the fill on surface and underground water;

Reclamation of the excess spoil will include a topsoil cover and subsoil layer. Infiltration through the reclamation is expected to be minimal based on the high clay content of these soils. In addition, laboratory data for the overburden shows that there is minimal potential for leaching of pollutants should infiltration rates become higher than expected.

The foundation of the excess spoil area also has high clay content with minimal potential for infiltration. This will provide an additional, natural barrier to protect ground water present beneath the proposed structure.

745.112: Ensure permanent impoundments are not located on the completed fill. Small depressions may be allowed by the Division if they are needed to retain moisture or minimize erosion, create and enhance wildlife habitat or assist revegetation, and if they are not incompatible with the stability of the fill; and

Permanent impoundments are not planned on the excess spoil area. Small depressions are also not planned in the excess spoil and are not viewed as a necessary enhancement to final reclamation based on average annual moisture data and the proposed slope configuration of the pile.

745.113: Adequately cover or treat the excess spoil that is acid- and toxic forming with nonacid nontoxic material to control the impact on the surface and ground water in accordance with R645-301-731.300 and to minimize adverse effects on plant growth and approved postmining land use.

Laboratory data representative of the overburden planned for disposal in the excess spoil area does not show acid- and toxic forming characteristics.

745.120: Drainage Control. If the disposal area contains springs, natural or manmade water courses, or wet weather seeps, the fill design will include diversions and underdrains as necessary to control erosion, prevent water infiltration into the fill and ensure stability.

A spring and seep survey available in Chapter 7 has identified no springs or wet weather seeps in the proposed excess spoil area. The final surface will be appropriately regraded to a contour that will route natural water from snowmelt and rainfall around the excess spoil as shown on the final contours Drawing 5-35. There are no manmade water courses present in the excess spoil area. No underdrains are planned for the excess spoil structure.

745.121: Diversions will comply with the requirements of R645-301-742.300

No diversions are planned in the excess spoil area.

745.122 : Underdrains

No underdrains are planned in the excess spoil area.

745.300: Durable Rock Fills

No Durable Rock fills are planned.

745.400: Preexisting Benches

The MRP does not contemplate disposal of excess spoil on preexisting benches.

Alton Coal Development, LLC will provide the Division, as part of the annual report for each calendar year, a plan view outline of the coal recovery, a 5' interval contour map of backfill progress and a reclamation progress map. This information will be submitted by June 30th of each calendar year.

560. Performance Standards

Coal mining and reclamation operations will be conducted in accordance with the approved permit and requirements of R645-301-510 through R645-301-553.

Geotechnical Analysis – Sediment Impoundments and Excess Spoil Structure

A revised Appendix 5-1 is provided to address the change in the design of the excess spoil structure and fill above approximate original contour. In addition to the spoil structure, Pond 1B is added along with a rapid drawdown analysis of the impoundments. This appendix replaces 5-1 in the Appendix Section of Chapter 5, Volume 3.

TAYLOR GEO-ENGINEERING, LLC

Alton Coal Development Coal Hollow Project

Slope Stability Analyses
For
PROPOSED EXCESS SPOIL STRUCTURE AND SEDIMENT IMPOUNDMENTS

Alton, Utah

Prepared for

Mr. Chris McCourt
Alton Coal Development
463 North 100 West, Suite 1
Cedar City, Utah 84721

REVISED
December 15, 2008

TGE Project No. 307001

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December 15, 2008

Mr. Chris McCourt
Alton Coal Development
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Subject: **Slope Stability Analyses - REVISED**
Proposed Excess Spoil Structure and Sediment Impoundments
Alton Coal Development Coal Hollow Project
Alton, Utah
TGE Project No. 307001
Original Document - April 23, 2007

Dear Mr. McCourt,

Enclosed are the findings of the slope stability study performed for the proposed Alton Coal Mine Excess Spoil Structure and mining related sediment impoundments. The purpose of the study was to verify the stability of the proposed spoil structure and impoundment slopes as designed by Alton Coal Development. The accompanying report describes the methods used in the study and our conclusions and recommendations.

Based on the results of our analyses, the proposed spoil structure may be constructed with 3:1 slopes up to a height of 90 feet above adjacent grade on the eastern 1/3 of the spoil pile and 120 feet above adjacent grade on the western 2/3 portion of the spoil pile. The proposed sediment embankments may be constructed with 2:1 slopes to a height of 15 feet. The owner should review the report in its entirety and specific recommendations.

If you have any questions, please feel free to contact the undersigned. The opportunity to be of service on this project is appreciated.

Respectfully submitted,
TAYLOR GEO-ENGINEERING, LLC

Alanson O. Taylor 12-15-08

Alanson O. Taylor, P.E.
Principal

Table of Contents

1.0 INTRODUCTION

This report presents the results of the geotechnical engineering study performed at the subject property. The proposed Alton Coal Mine is located within Township 40 South, Range 5 West Salt Lake Base and Meridian. As shown on Figure 1, Vicinity Map and Figure 2, Site Plan (Appendix A), the area investigated is located on the west side of State Highway 10, approximately 3 miles south of Alton, Utah.

The proposed Coal Hollow Mine will be an open pit coal mine approximately 440 acres in size with the portion addressed in this report comprising 80 acres. It is anticipated that during operation of the mine, approximately 2,000,000 cubic yards of coal will be mined per year with approximately 14,000,000 cubic yards of overburden moved per year. The mining equipment hauling the material is expected to range in weight from 100 tons to 240 tons. They will dump large piles up to 15 feet in height and large dozers (D10 to D11 in size) will spread the material, which will require tracking over the fill material several times during placement to four foot lifts.

For the initial 80 acres of the project, an excess spoil pile and 4 sedimentation ponds will be constructed. The purpose of the study was to verify the stability of the proposed spoil structure and impoundment slopes as designed by Alton Coal Development.

2.0 PREVIOUS STUDIES

Previous investigations have been conducted prior to this study. Several borings were drilled in 2005 by Petersen Hydraulic for a hydraulic study of the proposed mine. Prior to 2005, several test pits and borings were completed as part of an economical geologic study of the area to study overburden thickness and coal stratum thickness.

Test Pits SP-13, SP-15, SP-16 and CH-32, and borings CH-1-05, CH-3-05, CH-5-05 are relevant to this study. The location of the test pits and borings are shown on Figure 2. Borings logs were provided to TGE by Peterson Hydraulic for borings CH-1-05, CH-3-05 and CH-5-05. Logs of the Test Pits were not provided to TGE.

The following samples from the previous subsurface investigations by others were provided by Alton Coal Development to TGE:

ALTON COAL DEVELOPMENT TEST PIT AND BORING NUMBER	DESCRIPTION	SAMPLE DEPTH
SP-13	Sandy Clay (CL)	24"-48"
SP-13	Silty Sand (SM)	72" - 84"
SP-15	Silty Clay (CL-ML)	20" - 37"
SP-15	Silty Sand (SM)	57" - 73"

SP-16	Clay (CL)	36" - 56"
SP-16	Sandy Silt (ML)	56" - 68"
SP-16	Silt (ML)	68" - 90"
CH-32 (Coal Hollow)	Clay (CL)	31" - 54"
CH-32	Clay (CL)	54" - 72"
CH-1-05 (Rock Core)	Weathered Shale Fat Clay (CH)	40' - 55'
CH-3-05 (Rock Core)	Shale	41' - 44.5'
CH-5-05 (Rock Core)	Shale	48' - 55'
CH-5-05 (Rock Core)	Shale	98' - 108'

Samples SP-13, SP-15, SP-16 and CH 32, were combined to make a sample representative of the upper soil profile which TGE labelled SP-16-13. Samples CH-1-05 and CH-3-05 were hand crushed and combined to create sample CH-1-3. The remaining core samples were hand crushed and labelled CH-5-48 for the 48-55 ft. core and CH-5-98 for the 98-108 ft. core.

3.0 SCOPE OF WORK

This study included the following scope of work.

3.1 Site reconnaissance

A site reconnaissance was conducted by TGE on February 22, 2007. The purpose of the visit was to observe existing site conditions, determine boring locations, and pick up subsurface samples from the previous investigations that have been in storage.

3.2 Subsurface Exploration

Five (5) exploratory borings were drilled on February 28, 2007 and March 1, 2007, at the site to evaluate subsurface conditions. The borings were drilled with a hollow stem auger drill rig, to depths of 5 to 41 feet below the surface. As shown on Figure 2, 3 borings were located within the proposed mining area, one boring was located on the western point of the proposed excess spoil structure, and one boring was located near the proposed Sedimentation Pond #3 embankment.

Subsurface conditions observed in the exploratory boring were carefully documented at the time of drilling by TGE field personnel. Samples of representative soils were obtained from the borings for laboratory testing and visual classification. A description of the field exploration program and the logs of exploratory borings are presented on Figures 3 through 7 in Appendix B, Field Exploration.

3.3 Laboratory Testing

The representative samples obtained from the TGE field investigation and previous investigations were tested in the laboratory to aid in classification and to determine pertinent engineering properties. These tests included natural dry density and moisture content; Atterberg Limits, grain size analysis and unconfined compression shear tests, hydrometer analysis, and consolidated undrained triaxial shear tests with pore pressure measurement. A description of the laboratory test methods and test results are presented in Appendix C, Laboratory Testing Data Sheets. Results of the laboratory testing are presented on the boring logs, Table 1 and attached data sheets in Appendix C.

3.4 Engineering Analyses and Report

Data obtained from the exploratory borings and the laboratory testing program was evaluated. Geotechnical engineering analyses were performed which included preparation of this report presenting the findings and recommendations developed during the study.

4.0 SITE CONDITIONS

4.1 General

The area investigated consist of open range land vegetated with field grass, sage brush, pinions, and cedar trees. The surface of the area is fairly level with a gentle slope to the west. Relatively large drainage ravines, 1 to15 feet deep, traverse the northern portion of the property. Two small knolls are located on the west side of the property. The knolls appear to be comprised of weathered sandstone and alluvial deposits. A shallow ravine is also located between the knolls and south of Borings GT-4 and GT- 5. Topographic conditions are shown on Figure 2.

Snowmelt was observed seeping into the deep ravine from various locations. Snowmelt was also observed draining into a shallow ravine between the two knolls.

4.2 Subsurface Conditions

Alluvial/colluvial sediments were documented in the exploratory boring to depths of about 5 to 30 feet below existing ground surface. The alluvial/colluvial sediments consist of silty sand (SM), sandy silt (ML) and lean clay (CL). The sediments are underlain by highly weathered shale (fat clay, CH) and slightly to moderately weathered shale, which was documented by others to a maximum depth 41 feet. The shale is underlain by a coal deposits.

Detailed descriptions of subsurface conditions documented at the site are presented on the TGE Boring Logs Figures 3 through 7, and Boring Logs 8 through 10, Peterson Hydraulic logs redrawn with permission by Taylor Geo-Engineering (Appendix B).

4.3 Subsurface Water

Subsurface water was documented in the borings at a depth of 10± feet (recorded at the time of drilling) in borings GT-1, GT-2 and GT-3. Subsurface water was also observed at a depth of about 15 feet in GT-5. Boring GT-4 terminated at 5 feet below the surface on sandstone bedrock and was free of water.

Flowing sands were documented in the exploratory borings at a depth of 15 to 25 feet±. The flowing sands likely denote a zone of very loose sands that act as a liquid during drilling activities.

The subsurface investigation was performed during a period of high snowmelt which could add to the groundwater table at the time of the investigation. Seasonal fluctuations in groundwater conditions do occur, and groundwater fluctuations of several feet are not unusual. Numerous factors contribute to groundwater fluctuations such as seasonal recharge, regional and local irrigation, and periods of heavy precipitation. The detailed evaluation of these and other factors which may be responsible for groundwater fluctuations is beyond the scope of this study.

4.4 Subsurface Variations

Based on the results of the subsurface exploration and our experience, variations in the continuity and nature of subsurface conditions should be anticipated. Due to the nature and depositional characteristics of soils documented at the site, care should be taken in interpolating or extrapolating subsurface conditions between or beyond the exploratory borings.

5.0 SLOPE STABILITY ANALYSIS

Slope stability analyses were performed for the proposed excess spoil structure, for the interior slopes of the proposed sedimentation Ponds #1 through #4. Stability analyses were performed using GSTABL7 software and safety factors were calculated by the Modified Bishop Method.

Site ground acceleration for the pseudo-static stability analysis was based on the peak ground acceleration with a 2 percent probability of being exceeded in a 50-year period. [1] The peak bedrock ground acceleration (PGA) for the site with a 2 percent probability of being exceeded in 50 years is 0.29g. In accordance with industry standards, the pga was reduced by 50 percent and a value of 0.145g was used in the analyses.

Based on the information provided, TGE understands that the spoil pile will be constructed in thick lifts using large mining equipment; therefore, laboratory testing of the proposed fill materials was completed at 90 percent of the standard Proctor. The engineering characteristics obtained from laboratory testing were utilized in the stability analyses. Since the excess spoil

[1] USGS, 2002, U.S. Geological Survey seismic hazard maps: http://eqhazmap.usgs.gov.

pile will consist of soils from above the coal layer, the strength characteristics of the sandy clay, and fat clay from CH-1-3 and CH-5-48 were averaged to verify the stability of the slopes under static and seismic conditions. The average strength characteristics were reduced 10 percent to account for weakened strengths of materials placed to 85 percent of the standard Proctor.
Slope stability analyses for proposed Sedimentation Ponds #1, #1B, #2, and #4 used strength parameters obtained from sample SP-16-13, since the pond embankments in those areas will be constructed of soils representative of SP-16-13. The analyses considered a maximum slope height of 15 feet, even though not all the ponds will have slopes extending to 15 in height.

The slope stability analysis for the sedimentation Pond #3 embankment was completed using the soil unconfined compression strengths from samples obtained from boring GT-5. Laboratory testing indicated unconfined compressive strength of 9429 psf or a cohesive strength of 4700 psf. For stability purposes a cohesion of 700 psf and a friction angle (ø) of 10 degrees was utilized for static and seismic analyses. The strength values were conservatively reduced to assumed total stress parameters of 300 psf and 8 degrees for the rapid drawdown analysis.

Locations from which the cross-sections for the each of the slope analyses were taken from are shown on Figures 11 through 15, Appendix D. Lines A1-A1, A2-A2, B1-B1 and B2-B2 for the excess spoil pile are shown on Figure 11, Line F-F for the sedimentation ponds is shown on Figure 15, and Line E-E for Pond #3 is shown Figure 14. Profile views with the accompanying output files for each of the static and seismic slope stability analyses are shown on, Figures 16 through 37, in Appendix E, Profile Views and Output Files of Static and Pseudo-static Slope Stability Analyses.

5.1 Excess Spoil Structure

Based on the information provided, TGE understands the excess spoil structure will be a permanent structure after mining operations are complete. The proposed structure has been designed with maximum 3:1 (horizontal: vertical) slopes. As shown on Figure 11, Proposed Embankment Design, embankment height will vary from 75 feet at the east end to 120 feet at the west end.. The top of the embankment will descend to the northwest at a 2.2 percent grade.

The embankment will be comprised of soil deposits that overlie the coal bed to be removed during mining operations. Although the soils will likely consist of a mixture of silt, clay, sand, and shale, the stability analyses considered the materials separately. The analyses assume the materials will be compacted to at least 85 percent of the standard Proctor.

The subsurface information indicates that the subsurface profile varies between the area of GT-2/GT-3 and GT-5. Therefore, four stability analyses were performed representing Line A1-A1, A2-A2. Line B1-B1 and Line B2-B2, Figure 11. Additionally, TGE analyzed the spoil pile having a finished height of 120 feet in the area of the west end of the structure and 100 feet for the central portion of the structure and 75 to 86 feet for the east end of the structure.

Generally, the subgrade in the area of Lines A1-A1 and A2-A2 will be comprised of all backfill with the depth of backfill decreasing from east to west. The subgrade in the area of Lines B1-B1 and B2-B2 contains loose sand 10-feet to 20-feet in depth underlain by stiff clay then shale. It is anticipated that the groundwater elevation could be different after mining operations. TGE attempted to predict long term groundwater elevations after mining is complete with the depth of water shown on the attached stability profiles Figures 16 through 23.

Representative Factors of Safety of the stability analyses with the respective soil parameters used are tabulated below.

SLOPE SET	PHI,	COHESION	STATIC	PSEUDO-STATIC
A1-A1	19	240	1.6	1.1
A2-A2	19	240	1.6	1.1
B1-B1	19	240	1.7	1.1
B2-B2	19	240	1.6	1.1

SOIL STRENGTHS USED BELOW THE FILL

SAMPLE SET	PHI,	COHESION		
SP-16-13	29.6	94		
CH-1-3	21.6	319		
CH-5-48	20.1	321		
CH-5-98	25.4	216		

5.2 Sediment Impoundments #1, #2 and #4

Sediment Impoundments 1, 1B, 2 and 4 vary in size from 1.7 to 6.28 acre/feet. The proposed basin areas will be derived from digging into the original grades and constructing a portion of the embankments with the spoils. The depth of each sedimentation pond varies but the maximum depth shown on the attached plan sheets is 15 feet, Figures 12, 12B, 13 and 15. The profile obtained for this analysis is based upon Line F-F of Pond #4, Figure 15. The soils associated with the side slopes and dikes for the detention ponds will be similar to sample SP-16-13. The proposed ponds are intended to detain runoff from a major storm event. The slope analyses considered the basis full to spillway level for static and pseudo-static conditions.

A rapid drawdown analysis was completed assuming the spillways are plugged, the basin fills to top of the embankments and then the water is released or pumped down to the base of basins. The soil strengths utilized were based on total stress conditions as determined from the triaxial shear tests completed for this project. It should be noted that rapid drawdown is highly unlikely since spillway and outlet piping will be no more than 4-feet below the top of embankments.

The results of the stability analyses are tabulated below and graphically provided on Figures 24 through 26 in Appendix E.

LINE F-F

SEDIMENT IMPOUNDMENT	MAXIMUM HEIGHT	HEIGHT OF FREE BOARD	STATIC	PSEUDO-STATIC	RAPID DRAWDOWN
Pond #1, 1B, 2 & 4	15 feet	4 feet	2.2	1.3	1.2

5.3 Sediment Impoundment #3, Valley Pond

Based on the information provided, TGE understands that Valley View Pond will be a sedimentation pond located at the western most point of the mining area and at the base of the tailings embankment between the two knolls spoken of earlier in this report. The base of the pond will be cut 10 feet into the native stiff clay soils and the remainder of the embankment will constructed from soils derived from the excavation of the interior of the pond. The height of the fill for the pond embankment will be approximately 14-feet. The soils associated with the slopes and embankment for the pond will be similar to soils analyzed for samples from GT-5.

A rapid drawdown analysis was completed assuming the spillway is plugged, the basin fills to top of the embankment and then the water is released or pumped down to the base of basin. The soil strengths utilized were based on the stress conditions as previously discussed in section 5.0. It should be noted that rapid drawdown is highly unlikely since the spillway will be no more than 4-feet below the top of embankment.

The results are tabulated below and graphically provided on Figures 27 through 29 in Appendix E.

SEDIMENT IMPOUNDMENT	MAXIMUM HEIGHT	HEIGHT OF FREE BOARD	STATIC	PSEUDO-STATIC	RAPID DRAWDOWN
Pond #3	14 feet	4 feet	5.3	3.2	1.9

For temporary structures, such as Sedimentation Ponds #1, 1B, 2 , and 4, a static Factor of Safety of 1.3, 1.0 and 1.2 for Static, Pseudo-static and Rapid Drawdown conditions is considered adequate. For permanent structures such as the excess spoil structure and the sediment impoundment Pond #3, a static Factor of Safety of 1.5 and 1.0 for Static and Seismic conditions is considered adequate. Long Term rapid drawdown should be at least 1.2.

6.0 SETTLEMENT

The existing subgrade that will not be mined but will be supporting the 100 to 120 feet of spoils will potentially consolidate under the 13,000 psf to 14,000 psf loads associated with the spoil pile. Additionally, as the spoil pile is constructed, the spoil materials placed near the base of the spoil pile will consolidate to densities greater than densities at the time of initial placement.

Consolidation of the native materials in the area of GT-3 under the 110 foot embankment could be on the order of 4 to 5 feet. Consolidation of the native materials in the area of GT-4 and GT-5 will be negligible based on the stiffness of the clay soils and the presence of sandstone bedrock.

Consolidation of the spoil materials after placement will be on the order of 0 to 15 percent, depending the depth below finish grade the spoil is located. In all cases, since the spoil pile will be constructed over a period of several years, the effects of the differential settlement across the structure is anticipated to be minimal and should not affect the short term or long term performance of the spoil pile.

7.0 BULKING

During mass excavation operations of dense materials, the placement of spoils generally requires more volume of space during placement than that originally occupied by the same soil mass in its native state. Based on dry densities of the shale materials in their intact state and the standard Proctors conducted for this project, the shale spoils will have a a volume approximately 30 percent higher after mining than prior to mining. The silty sand and clay soils will have minimal bulking with an average of approximately 10 percent. However, as indicated in sectio**n 5.0 SETTLEMENT**, the overall apparent bulking may be lower after the fill pile is complete due to post placement consolidation.

8.0 RECOMMENDATIONS

The proposed excess spoil structure and sediment ponds may be constructed as designed by Alton Coal Development. The laboratory shear tests were conducted on materials compacted to at least 90 percent of the standard Proctor. Analysis of the spoil pile was based on reduce strengths to account for lighter compaction. Therefore, fill materials should be placed and compacted to at least 85 percent of the standard Proctor (ASTM test method 698) for the spoil pile and 90 percent for the sedimentation embankments. An engineer from TGE or his representative should be present periodically to verify that the placement of fill materials are being completed properly and that testing inspection is taking place in accordance with Appendix F of this document and the State of Utah R645 – Coal Mining Rules.

It is anticipated that the large mining equipment used to haul and doze the spoil pile material will provide the required loading to achieve 85 percent compaction. The fill used to construct the embankments for the sedimentation ponds may require vibratory compaction during placement to achieve the 90 percent compaction as required.

Based on the presence of groundwater (see Section 4.3), a dewatering plan will likely need to be implemented during excavation operations. The satiability of the cut walls of the strip mining area will be dependent on temporarily diverting groundwater seepage from the excavation. The design of a dewatering plan was beyond the scope of this study.

If a dewatering plan is properly implemented and the temporary cut slopes are kept dry, TGE recommends that temporary cuts in the stiff clay and shale may be no greater than 1H:1V (horizontal:vertical), and temporary cuts in the lean clay and sand layers my no greater than 2H:1V. If after inspection of the shale formation and additional groundwater observations are made, the cut slopes may be steepened as directed by TGE.

Based on the information provided, TGE's understands that the spoil pile is not intended to be constructed for the future support of structures. The recommendations for fill placement as provided in Appendix F, Recommended Earthwork Specifications, are based on this understanding. Therefore, TGE does not recommend that the excess spoil pile be used in the future for the support of structures since the material is being placed with a moderate level of compaction (at best) and long term differential settlement of the pile will occur.

9.0 CLOSURE

The findings and recommendations of this report were prepared in accordance with generally accepted professional geotechnical engineering principles and practice in this area of Utah at this time. There is no other warranty, either express or implied.

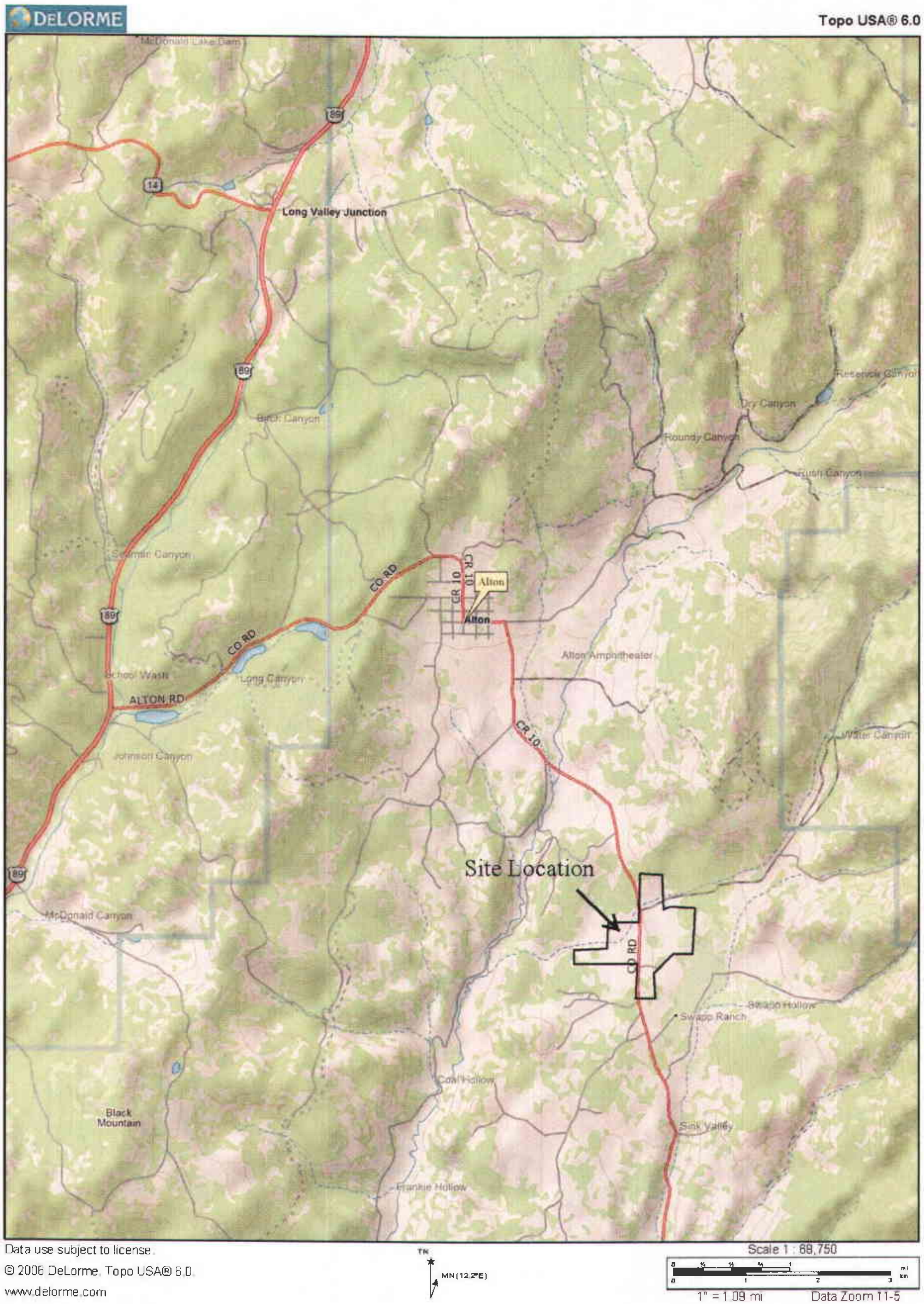
The conclusions and recommendations presented herein are based on the results of limited subsurface exploration and laboratory testing, combined with interpolation and extrapolation of subsurface conditions between and beyond exploration locations. As the project evolves, TGE's continued consultation and construction monitoring should be considered an extension of the services performed to date. Subsurface conditions may differ in some locations from the conditions observed in the explorations, and may require additional analyses and possibly modified recommendations.

This report was written for the exclusive use of Alton Coal Development and only for the proposed project described herein. TGE is not responsible for technical interpretations by others or exploratory information which has not been described or documented in this report. Specific questions or interpretations concerning the findings and conclusions presented herein may require written clarification to avoid possible misunderstandings. The opportunity to be of service is appreciated.

APPENDIX A

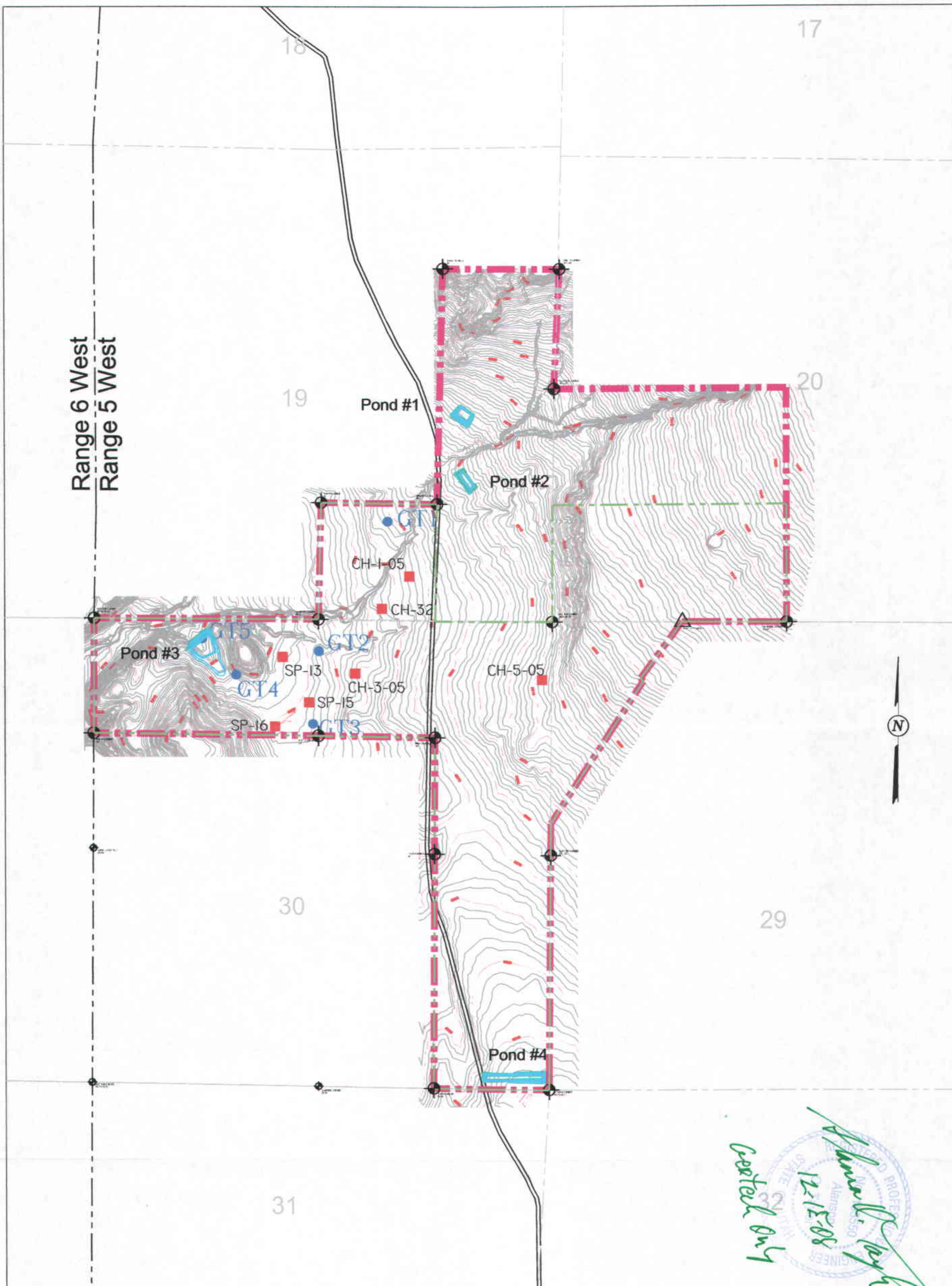
VICINITY MAP AND SITE PLAN

VICINITY MAP



Alton Coal Hollow Mine

Figure No. 1



Township 39 South

CONTOURS ARE SHOWN AT 2' INTERVALS.

LEGEND:
PROJECT AREA
PRIVATE COAL OWNERSHIP
COAL LINE BOUNDARY
SECTION LINE
FOUND SECTION CORNER
FOUND PROPERTY CORNER

DRAWN BY: C. McCOURT J. STANSFIELD	CHECKED BY: CRM/APC
DRAWING: 5-39	DATE: 4/20/07
	SCALE: 1" = 1000'
JOB NUMBER: 1400	SHEET

REVISIONS	
DATE:	BY:

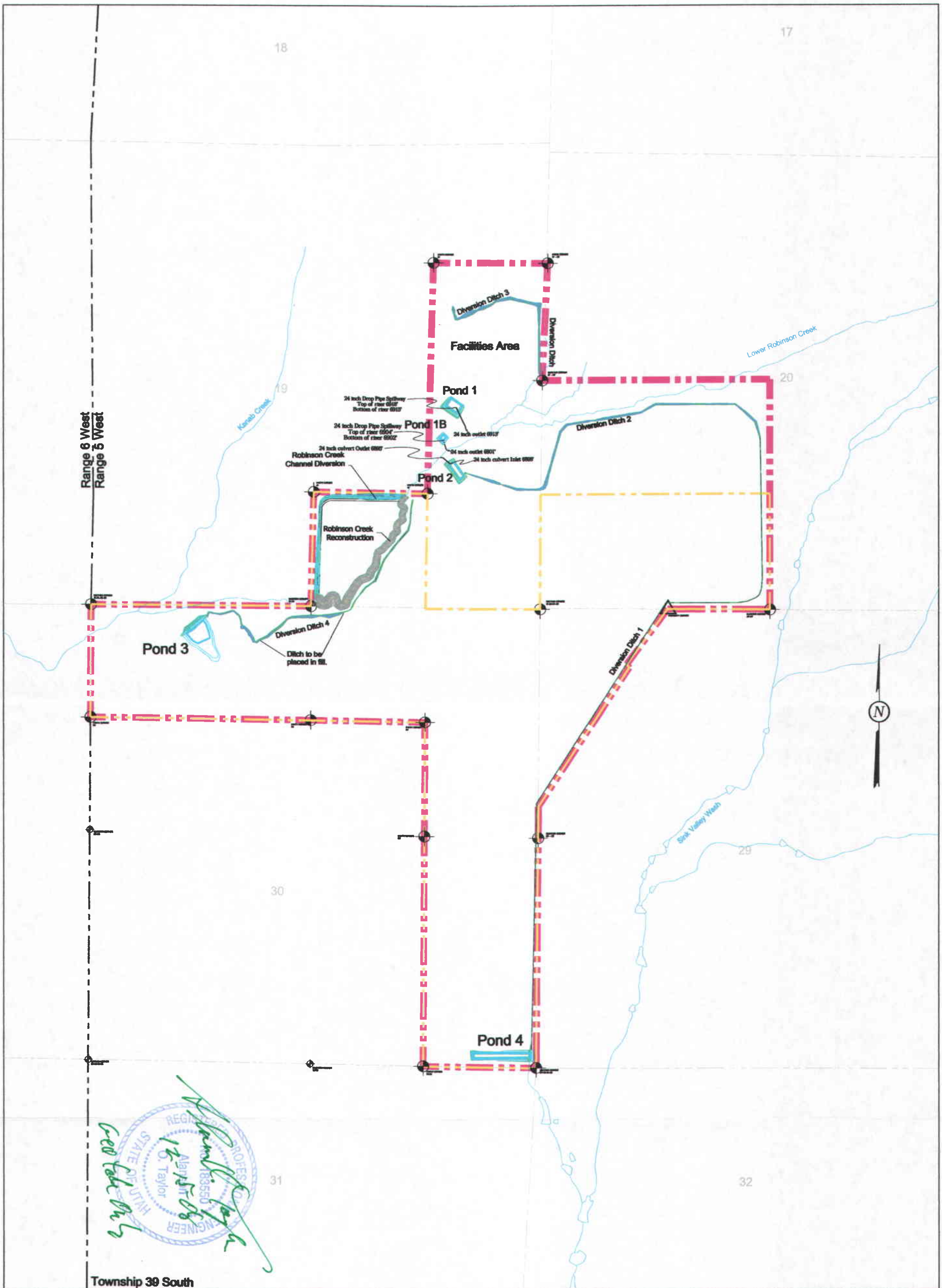
GEOTECH SAMPLES/ DRILLING LOCATIONS

COAL HOLLOW PROJECT ALTON, UTAH

DRAWING: 5-39

Registered Professional Engineer 275875-2202 CHRIS R. McCOURT State of Utah

Figure No. 2



LEGEND:
- PERMIT BOUNDARY
- PRIVATE COAL OWNERSHIP
- SECTION LINE
- FOUND SECTION CORNER
- FOUND PROPERTY CORNER
- PROPOSED SEDIMENT IMPOUNDS
- DIVERSION DITCHES
- EXISTING DRAINAGES

DRAWN BY: J. STANSFIELD	CHECKED BY: CRM/GG
DRAWING: 5-25	DATE: 4/20/07
	SCALE: 1" = 500'
JOB NUMBER: 1400	SHEET

REVISIONS

DATE:	BY:
12/02/08	CRM

DIVERSION DITCH & SEDIMENT IMPOUND PLAN VIEW

COAL HOLLOW PROJECT
ALTON, UTAH

DRAWING: 5-25

Figure No. 2B

Coal Hollow Project

463 North 100 West, Suite 1
Cedar City, Utah 84720
Phone (435)867-5331
Fax (435)867-1192

APPENDIX B

FIELD EXPLORATION

APPENDIX B
FIELD EXPLORATION

The program of subsurface exploration consisted of drilling five (5) borings to explore subsurface conditions in the vicinity of the proposed structures and to obtain samples for laboratory testing. Subsurface conditions observed in the borings were carefully documented by experienced TGE field personnel. Subsurface materials were classified in accordance with Unified Soil Classification System (ASTM Method D 2488).

Boring locations are shown on Figure 2, Site Plan (Appendix A). Borings were located by TGE field personnel using surveyed property corners, and information shown on a Figure 2.

Exploratory borings were drilled to depths of about 5 to 41 feet below existing ground surface. The borings were advanced with a truck mounted drill rig using 8-inch outside diameter hollow-stem augers.

Relatively undisturbed and bulk samples of representative soils were obtained from the borings at frequent intervals for laboratory testing and visual classification. Relatively undisturbed samples were obtained using either a 1.4-inch inside diameter (ID) split-spoon sampler (Standard Penetration Test Sampler), a 2-inch ID "Modified California" sampler (lined with 4-inch brass sleeves), or a Shelby Tube sampler.

A sampler was advanced a maximum of 18 inches by successive drops ("blows") from a 140-pound hammer falling 30 inches. The number of blows required to advance the sampler three successive 6-inch increments was recorded. The total number of blows required to advance a sampler the second and third 6-inch increment represents the penetration resistance value (N-value). For the 1.4-inch sampler, this test constitutes the Standard Penetration Test (SPT) as described by ASTM Method D 1586.

A description of soils observed in the borings, the sample types, depths at which the samples were taken, and N-values are shown on the Logs of Exploratory Borings included in this appendix. A legend of boring symbols and the Unified Soil Classification System is also included herein.

DRILL LOG

TAYLOR GEO-ENGINEERING

Figure No. 3

Boring No. GT-1

Date of Drilling: February 28, 2007

Project : Alton Hollow Project
Project No.: 307001
Location: Alton, Utah
Elevation: 6900 feet

Drilling Company: GTS
Equipment: Mobile B-80
Logged By: A.T.

GWT: 10 feet

Depth (ft.)	Graphic	USCS	Sample	Description	Laboratory Test Results	Other Data
0						
1				TOPSOIL: Light brown, moist, loose, 6" thick.		
2				LEAN CLAY: Very stiff, moist to wet, greenish brown.		
3						
4						
5						
6			X			2" ID Sampler
7			X			29, 53, 50/5"
8						
9		CL				
10						2" ID Sampler
11			X		WC = 12.6%	21, 56, 50/3"
12			X		DD = 111.6 pcf	
13					LL = 47 PI = 31	
14						
15						
16			X			2" ID Sampler
17			X			20, 37, 50/5"
18						
19						
20						
21			X		WC = 14.4	2" ID Sampler
22			X			12, 26, 40
23				FAT CLAY: Stiff, moist to wet, probable perched water between 22 and 25 feet, some pebbles and gravel, gray with tan specs.		
24						
25						
26			X		WC = 28.6%	2" ID Sampler
27			X		DD = 95.0 pcf	8, 16, 25
28		CH			LL = 69 PI = 52	
29					UC = 4777 psf	
30			X			2" ID Sampler
31			X			7, 24, 26
32						
33						
34						
35		SHALE		SHALE: Weathered, hard, moist, brownish gray to gray.		
36			X			2" ID Sampler
37				Boring Terminated at 36 Feet.		17, 50/5"
38						
39						
40						
41						
42						
43						
44						
45						

Notes: 140 lb sampler using drive cable. Low Efficiency.

DRILL LOG

TAYLOR GEO-ENGINEERING

Figure No. 4

Boring No.: GT-2

Date of Drilling: March 1, 2007

Project : Alton Hollow Project
Project No.: 307001
Location: Alton, Utah
Elevation: 6900 feet

Drilling Company: GTS
Equipment: Mobile B-80
Logged By: A.T.

GWT: 10 feet

Depth (ft.)	Graphic	USCS	Sample	Description	Laboratory Test Results	Other Data
0						
1				TOPSOIL: Light brown, moist, loose, 6" thick.		
2				SILTY SAND: Medium dense to loose, moist to wet, gray to tan.		
3						
4						
5						
6			X			Standard Spoon
7			X			11, 10, 13
8						
9		SM				
10						2" ID Sampler
11			X		WC = 10.6%	5, 8, 7
12			X		-200 = 33.3%	
13						
14						
15						
16			X	No Recovery Due to GWT and Loose Sand.		2" ID Sampler
17			X			3, 5, 8
18						
19				CLAYEY SAND: Very loose, wet, tan.		
20		SC				
21			X			2" ID Sampler
22			X	LEAN CLAY: Some sand, very soft, wet, tannish gray.		2, 3, 5
23						
24		CL				
25						
26			X	Liquified with vibration.	WC = 27.8%	2" ID Sampler
27			X		LL = 37 PI = 19	2, 6, 9
28						
29						
30			X			2" ID Sampler
31			X	FAT CLAY: With sand, medium stiff, moist, bluish gray with dark gray seams.	WC = 18.5%	3, 6, 8
32		CH				
33						
34						
35		SHALE		SHALE: Weathered, hard, moist, light gray to dark gray.		
36			X			2" ID Sampler
37				Boring Terminated at 35.5 Feet.		50/5"
38						
39						
40						
41						
42						
43						
44						
45						

Notes: 140 lb sampler using drive cable. Low Efficiency.

DRILL LOG

TAYLOR GEO-ENGINEERING

Figure No. 5

Boring No.: GT-3

Date of Drilling: February 28, 2007

Project : Alton Hollow Project
Project No.: 307001
Location: Alton, Utah
Elevation: 6900 feet

Drilling Company: GTS
Equipment: Mobile B-80
Logged By: A.T.

GWT: 15 feet

Depth (ft.)	Graphic	USCS	Sample	Description	Laboratory Test Results	Other Data
0						
1				TOPSOIL: Light brown, moist, loose, 6" thick.		
2				SILTY SAND: Medium dense to loose, moist to wet, gray to tan.		
3						
4						
5						
6						2" ID Sampler
7						12, 20, 16
8						
9						
10						2" ID Sampler
11					WC = 11.0%	5, 6, 11
12					-200 = 37.5%	
13						
14		SM				
15						
16				No Recovery Due to GWT and Loose Sand.		2" ID Sampler
17						3, 3, 3
18						
19				CLAYEY SAND: Very loose, wet, tan.		
20						
21						2" ID Sampler
22				LEAN CLAY: Some sand, very soft, wet, tannish gray.		5, 5, 8
23						
24						
25						
26				Liquified with vibration.		2" ID Sampler
27						6, 26, 75/5.5"
28						
29				HIGH PLASTICITY SILT: Very Stiff, wet, dark gray to black.	WC = 37.3%	
30		MH			DD = 76.6 pcf	2" ID Sampler
31					LL = 74 PI = 38	6, 18, 30
32					UC = 1956 psf	
33				FAT CLAY: Very Stiff, moist, gray. Sampling terminated due to water intrusion into hole from above layers.		
34						
35						
36		CH				2" ID Sampler
37						8, 25, -
38						
39						
40		SHALE		SHALE: Weathered, hard, moist, light gray to dark gray.		2" ID Sampler
41						13,50/5"
42				Boring Terminated at 41 Feet.		
43						
44						
45						

Notes; 140 lb sampler using drive cable. Low Efficiency.

DRILL LOG

TAYLOR GEO-ENGINEERING

Figure No. 6

Boring No.: GT-4

Date of Drilling: March 1, 2007

Project : Alton Hollow Project
Project No.: 307001
Location: Alton, Utah
Elevation: 6900 feet

Drilling Company: GTS
Equipment: Mobile B-80
Logged By: A.T.

GWT: NA

Depth (ft.)	Graphic	USCS	Sample	Description	Laboratory Test Results	Other Data
0						
1				TOPSOIL: Light brown, moist, loose, 6" thick.		
2				SILTY SAND: Medium dense, moist, tan.		
3		SM				
4						Standard Spoon
5			X			50/0"
6				Boring Terminated at 5 Feet on sandstone bedrock.		
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
32						
33						
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						
44						
45						

Notes: 140 lb sampler using drive cable. Low Efficiency.

DRILL LOG

TAYLOR GEO-ENGINEERING

Figure No. 7

Boring No.: GT-5 | Date of Drilling: March 1, 2007

Project : Alton Hollow Project
Project No.: 307001
Location: Alton, Utah
Elevation: 6900 feet

Drilling Company: GTS
Equipment: Mobile B-80
Logged By: A.T.

GWT: 15 feet

Depth (ft.) 0	Graphic	USCS	Sample	Description	Laboratory Test Results	Other Data
1				**TOPSOIL: Light brown, moist, loose, 6" thick.**		
2				FAT CLAY: Very Stiff, moist, dark brown with tan specs.		
3				Some pebbles at 15 feet and saturated sand layers at 15		
4				feet. Potential perched water.		
5						
6					WC = 18.7%	Standard Sampler
7					DD = 108.3 pcf	12, 26, 32
8		CH			LL = 63 PI = 44	
9						
10						2½" ID Sampler
11					WC = 17.1%	14, 50, 50/5"
12					DD = 102.0 pcf	
13					LL = 63 PI = 45	
14					UC = 9429 psf	
15						
16					WC = 17.2%	2" ID Sampler
17					DD = 120.0 pcf	20, 40, 50/5"
18				Boring Terminated at 16.5 feet.		
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
32						
33						
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						
44						
45						

Notes: 140 lb sampler using drive cable. Low Efficiency.

DRILL LOG

PETERSON HYDRAULIC

Figure No. 8

Boring No.:	CH-01-05	Date of Drilling:	Nov. 9-10, 2005
Project :	Alton Hollow Project	Drilling Company:	DA Smith Drillers
Project No.:	307001	Equipment:	
Location:	Alton, Utah	Logged By:	Eric Peterson
Elevation:	6900 feet		
		GWT:	Not Indicated

Depth (ft.)	Graphic	USCS	Sample	Description	Laboratory Test Results	Other Data
0						
2				TOPSOIL: Light brown, moist, loose, 6" thick.		
4–38		CL		0-8 Soil 8-40 Clay, gray (auger drilled)		
40–54		CH		40-55 Silty clay, gray, dense, and 0.5' bentonite layer, white to orange	ø = 21.6 cohesion = 319 psf OM = 20.5 MDD = 101.9 LL = 53 PI = 32	
56–58		SHALE		55-56 Silty shale, gray. 56-58 Carbonaceous shale, dark gray.		
60–72		COAL		58-59.2 Low-grade Coal and organic shale, dark gray to black, some fossiliferous intervals 59.2-73 Coal, black with some brown mottled zones.		
74–80		SHALE		73-75.8 Siltstone, gray, clayey. 75.8-76.0 Shale, gray; 76-76.3 Siltstone, gray, clayey, laminated; 76.3-76.6 Shale, gray 76.6-80 Organic siltstone/shale, highly laminated, dark gray		
82–90						

Notes: Auger (0-40 feet), Continous NQ core (40-80 feet)
This boring is close to GT-1

DRILL LOG

Peterson Hydraulic

Figure No. 9

Boring No.: CH-03-05

Date of Drilling: Nov. 12, 2005

Project : Alton Hollow Project
Project No.: 307001
Location: Alton, Utah
Elevation: 6900 feet

Drilling Company: DA Smith Drillers
Equipment:
Logged By: Eric Peterson

GWT: Not Indicated

Depth (ft.)	Graphic	USCS	Sample	Description	Laboratory Test Results	Other Data
0						
2				TOPSOIL: Light brown, moist, loose, 6" thick.		
4						
6						
8						
10						
12						
14						
16						
18				No Core (Auger hole)		
20						
22						
24						
26						
28						
30						
32						
34						
36						
38						
40						
42		SHALE		41-44.5 Carbonaceous shale, waxy, soft, dark gray to black		
44						
46				44.5-46 Low-grade coal, cabonaceous silty shale		
48				46-61 Coal, black, monor brownish coal, minor pyrite		
50						
52						
54		COAL		46-61 Coal, black, monor brownish coal, minor pyrite		
56						
58						
60				61-61.5 Low-grade coal, carbonaceous shale, some fairly		
62				dissembinted pyrite		
64		SHALE		61.5-63.5 Silty shale, waxy, gray		
66						
68						
70						
72						
74						
76						
78						
80						
82						
84						
86						
88						
90						

Notes: Auger (0-41 feet), Continous NQ core (41-63.5 feet)
This boring is close to GT-2

DRILL LOG

PETERSON HYDRAULIC

Figure No. 10-A

Boring No.: CH-01-05
Date of Drilling: Nov. 8, 2005

Project : Alton Hollow Project
Project No.: 307001
Location: Alton, Utah
Elevation: 6900 feet

Drilling Company: DA Smith Drillers
Equipment:
Logged By: Eric Peterson

GWT: 15 feet

Depth (ft.) 0	Graphic	USCS	Sample	Description	Laboratory Test Results	Other Data
2				TOPSOIL: Light brown, moist, loose, 6" thick.		
4		CL		0-5 Soil, Clayey		
6				5-14 Gravel with sand and silt, reddish		
8		GM				
10						
12						
14						
16				14-16.6 Clayey silt, wet		
18				16.5-20 Clay, moist, wet		
20						
22				20-34 Silty clay, dark gray, less dense than above		
24		CL				
26						
28						
30						
32						
34				34-48 Clay, stiff, medium gray		
36						
38						
40		CH				
42						
44						
46						
48						
50				48-55 Dark gray silty carbonaceous shale, soft, waxy texture, some minor interbedded shaley siltstone, iron-stained fracture zone at 50-51 feet		
52					ø = 20.1	
54					cohesion = 321 psf	
56				55-68 Carbonaceous shale with minor silt, dark gray to black, more competent than above	OM = 20	
58					MDD = 99.5	
60					LL = 61 PI = 38	
62						
64						
66						
68				68-69.5 Fractured/broken carbonaceous shale, dark gray to black		
70		SHALE				
72				69.5-88.5 Carbonaceous shale, dark gray to black, soft, waxy texture		
74						
76						
78						
80						
82						
84						
86						
88						
90				88.5-89.5 Medium gray siltstone		

Notes: Auger (0-40 feet), Continous NQ core (40-175 feet)

DRILL LOG

PETERSON HYDRAULIC

Figure No. 10-B

Boring No.: CH-01-05

Date of Drilling: Nov. 8, 2005

Depth (ft.)	Graphic	USCS	Sample	Description	Laboratory Test Results	Other Data
92		CH		89.5-92 Bentonite, medium to dark gray, pure		
94				92-92.5 Siltstone, medium gray		
96				92.5-107 Cabonaceous shale, dark gray to black, soft, waxy		
98				texture	ø = 25.4	
100					cohesion = 216 psf	
102				107-109.5 Siltstone and cabonaceous shale, interbedded,	OM = 17.0	
104				thinly laminated, dark gray	MDD = 108.4	
106				109.5-110 Carbonaceous shale, dark gray to black, soft,	LL = 53 PI = 31	
108				waxy texture		
110		SHALE		110-115 Siltstone and cabonaceous shale, interbedded,		
112				thinly laminated, dark gray		
114				115-121.5 Carbonaceous shale, dark gray to black, soft,		
116				waxy texture, (poor core recovery)		
118				121.5-122 Limey claystone, dark gray, fossiliferous, (small,		
120				open fracture in this interval)		
122				122-125 Little or no recovery in this zone		
124				125-127.5 Carbonaceous shale, dark gray to black, soft,		
126				waxy texture		
128		CH		127.5-128 Bentonite, medium to light gray		
130				128-135 Carbonaceous shale, dark gray to black, soft, waxy		
132		SHALE		texture		
134				135-137 Carbonaceousw shale, harder than above		
136				137-138 Bentonite and interbedded carbonaceous shale,		
138		CH		dark and medium gray, thinly laminated		
140				138-143.5 Carbonaceous shale, dark gray to black, soft		
142				143.5-144 Bentonite and interbedded carbonaceous shale,		
144				dark and medium gray, thinly laminated		
146		SHALE		144-146 Carbonaceous shale and thin interbeds of siltstone,		
				146-152.5 Siltstone with minor thin interbeds of		
148				cabonaceous shale, mottled gray to black		
150						
152						
				152.5-154.7 Coal, low grade or highly carbonaceous shale,		
154				black, abundant white fossils/fossil hash		
156						
158						
160		COAL				
162						
164				154.7-171.5 Coal, black with some brown mottled zones.		
166						
168						
170						
172				171.5-171-7 Coal, low grade, brown and black		
174				171.7-173.5 Carbonaceous shale, dark gray to black		
176				173.5-175 Siltstone, gray, interbedded with minor		
178				carbonaceous shale		
180						
182						
184						
186						
188						
190						
192						

Notes: Auger (0-40 feet), Continous NQ core (40-175 feet)

APPENDIX C

LABORATORY TESTING DATA

APPENDIX C
LABORATORY TESTING PROGRAM

Laboratory tests were conducted on representative soil samples obtained from the exploratory borings for the purpose of evaluating specific engineering properties and to aid in classification. Laboratory testing was performed at IGES Geotechnical Laboratory (Murray, Utah). A summary of the various laboratory tests, conducted in accordance with ASTM or other approved procedures follows:

Tests Conducted:	To Determine:
Natural Moisture Content ASTM D 2216	Moisture content representative of field conditions at the time samples were taken.
Natural Dry Density ASTM D 2922	Dry unit weight of samples, representative of in-place conditions at the time samples were taken.
Grain Size Analysis ASTM D 422	Size and distribution of soil particles (i.e. gravel, sand, and the combined percentage of clay and silt) within a soil sample.
Hydrometer ASTM D 422	Size and distribution of soil particles (i.e. gravel, sand, clay, and silt) within a soil sample.
Atterberg Limits ASTM D 423 and D 424	Effect of varying water content on the consistency of fine-grained soils.
Standard Proctor ASTM D 698	Determine the maximum density and optimum moisture for fill compaction effort.
Unconfined Compressive Strength ASTM D 2166	Compressive strength of sample, determined without a confining pressure.
Triaxial Shear Test	Angle of friction and cohesion under a confining pressure.

Results of the laboratory tests are summarized on Table-1, Summary of Laboratory Test Results. Laboratory data sheets are provided in Appendix C-1 and C-2.

TAYLOR GEO-ENGINEERING, LLC

TABLE 1

Alton Coal Hollow Project

TGE Project No. 307001

Summary of Laboratory Test Results

Sample Location		Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation				Atterberg Limits		Unconfined Compressive Strength (psf)	Standard Proctor		CU Triaxial Test		USCS
Boring No.	Depth (ft.)			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Plasticity Index (%)		Optimum Moisture (%)	Maximum Dry Density (pcf)	Effective (ø)	Effective Cohesion (psf)	
GT-1	10-11.5	12.6	111.6					47.0	31.0						CL
GT-1	20-21.5	14.4													CL
GT-1	25-26.5	28.6	95.0					69.0	52.0	4777.0					CH
GT-2	10-11.5	10.6				33.3									SM
GT-2	25-26.5	27.8						37.0	19.0						CL
GT-2	30-31.5	18.5													CL
GT-3	10-11.5	11.0				37.5									SM
GT-3	30-31.5	37.3	76.6					74.0	38.0	1956.0					MH
GT-5	5-6.5	18.7	108.3					63.0	44.0						CH
GT-5	10-11.5	17.1	102.0					63.0	45.0	9429.0					CH
GT-5	15-16.5	17.2	120.0												CH
SP-16-13	39120.0			0.0	20.5	51.1	28.4	31.0	15.0		17.0	110.4	29.6	94.0	CL
CH-1-3	40 - 44.5			1.1	4.4	57.8	37.8	53.0	32.0		20.5	101.9	21.6	319.0	CH
CH-5-48	48 - 55	5.7	132.9	13.2	40.7	46.1		61.0	38.0		20.0	99.5	20.1	321.0	SC
CH-5-98	98 - 108			7.4	29.7	62.9		53.0	36.0		17.0	108.4	25.4	216.0	CH

APPENDIX C-1

LABORATORY TESTING DATA for BORINGS GT-1 through GT-5

Moisture Content and Unit Weight of Soil

(In General Accordance with ASTM D2937 and D2216)

IGES

Project: Taylor Geo-Engineering
No: M00991-002
Location: _
Date: 3/9/2007
By: NB

Sample Info.	Boring No.	GT-1	GT-1	GT-2	GT-2	GT-2	GT-3	GT-5	GT-5
	Sample:								
	Depth:	10-11.5'	20.21.5'	10-11.5'	25-26.5'	30-31.5'	10-11.5'	5-6.5'	15-16.5
Unit Weight Info.	Sample height, H (in)	1.110						4.449	2.430
	Sample diameter, D (in)	1.890						1.373	1.824
	Sample volume, V (ft^3)	**0.0018**						**0.0038**	**0.0037**
	Wt. rings + wet soil (g)	102.87						222.43	234.72
	Wt. rings/tare (g)	0.00						0.00	0.00
	Moist soil, Ws (g)	**102.87**						**222.43**	**234.72**
	Moist unit wt., γ_m (pcf)	**125.73**						**128.53**	**140.70**
Moisture	Wet soil + tare (g)	292.45	670.40	438.87	295.22	380.60	492.21	283.41	385.29
	Dry soil + tare (g)	276.79	603.47	410.17	264.26	345.01	457.38	262.52	350.82
	Tare (g)	152.92	140.21	140.53	152.70	152.72	139.84	150.75	150.62
Moisture Content, w (%)		**12.6**	**14.4**	**10.6**	**27.8**	**18.5**	**11.0**	**18.7**	**17.2**
Dry Unit Wt., γ_d (pcf)		**111.6**						**108.3**	**120.0**

Entered by:___________

Reviewed:___________

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

IGES

Project: Taylor Geo-Engineering
No: M00991-002
Location:
Date: 3/13/2007
By: BRR

Boring No.: GT-1
Sample:
Depth: 10-11.5
Description: Not Requested

Preparation method: Air Dry
Liquid limit test method: Multipoint

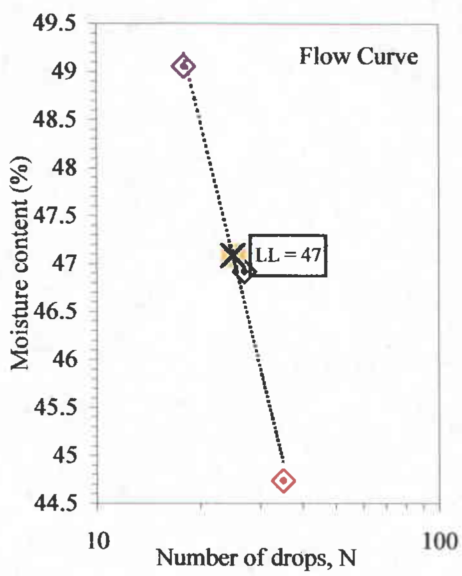
Plastic Limit

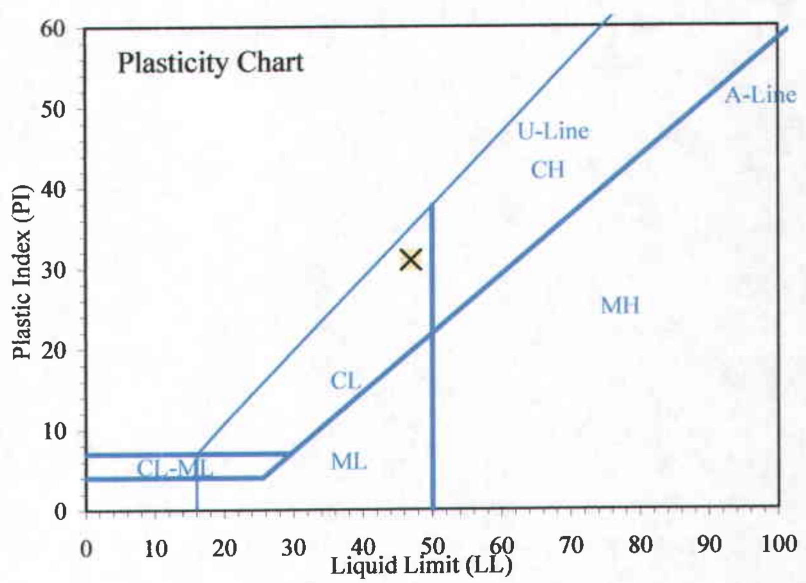
Determination No	1	2				
Wet Soil + Tare (g)	9.48	10.49				
Dry Soil + Tare (g)	8.37	9.24				
Moisture Loss (g)	1.11	1.25				
Tare (g)	1.39	1.39				
Dry Soil (g)	6.98	7.85				
Moisture Content, w (%)	15.90	15.92				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	35	27	18			
Wet Soil + Tare (g)	10.04	11.88	10.87			
Dry Soil + Tare (g)	7.36	8.53	7.75			
Moisture Loss (g)	2.68	3.35	3.12			
Tare (g)	1.37	1.39	1.39			
Dry Soil (g)	5.99	7.14	6.36			
Moisture Content, w (%)	44.74	46.92	49.06			
One-Point LL (%)		47				

Liquid Limit, LL (%)	47
Plastic Limit, PL (%)	16
Plasticity Index, PI (%)	31





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils
(ASTM D4318)

IGES
© IGES 2004

Project: Taylor Geo-Engineering
No: M00991-002
Location:
Date: 3/15/2007
By: NB

Boring No.: GT-1
Sample:
Depth: 25-26.5
Description: Not Requested

Preparation method: Air Dry
Liquid limit test method: Multipoint

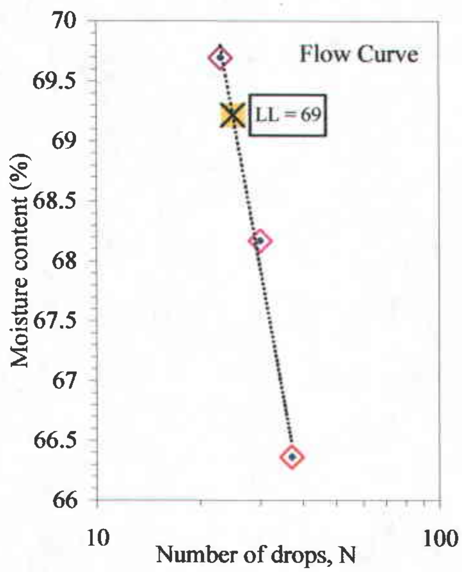
Plastic Limit

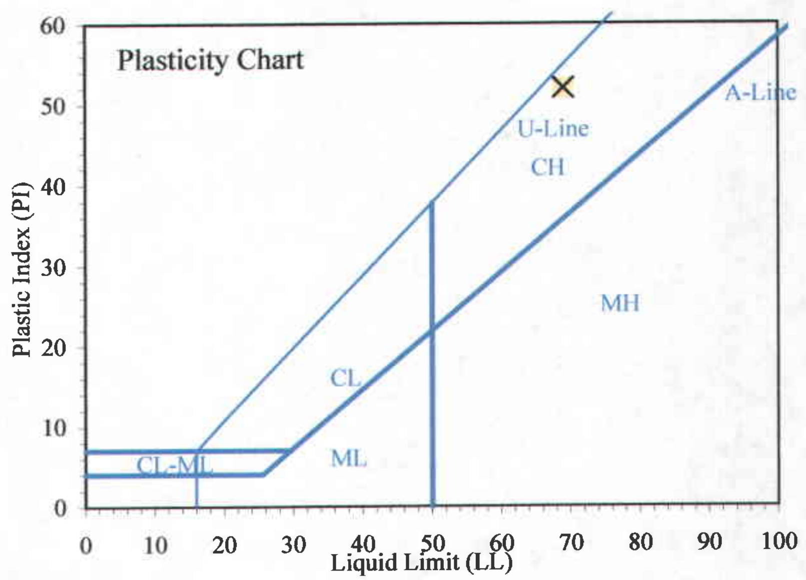
Determination No	1	2				
Wet Soil + Tare (g)	4.1	4.23				
Dry Soil + Tare (g)	3.7	3.81				
Moisture Loss (g)	0.4	0.42				
Tare (g)	1.38	1.38				
Dry Soil (g)	2.32	2.43				
Moisture Content, w (%)	17.24	17.28				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	37	30	23			
Wet Soil + Tare (g)	8.66	7.73	7			
Dry Soil + Tare (g)	5.76	5.16	4.7			
Moisture Loss (g)	2.9	2.57	2.3			
Tare (g)	1.39	1.39	1.4			
Dry Soil (g)	4.37	3.77	3.30			
Moisture Content, w (%)	66.36	68.17	69.70			
One-Point LL (%)		70	69			

Liquid Limit, LL (%)	**69**
Plastic Limit, PL (%)	**17**
Plasticity Index, PI (%)	**52**





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

IGES

Project: Taylor Geo-Engineering
No: M00991-002
Location:
Date: 3/13/2007
By: BRR

Boring No.: GT-2
Sample:
Depth: 25-26.5
Description: Not Requested

Preparation method: Air Dry
Liquid limit test method: Multipoint

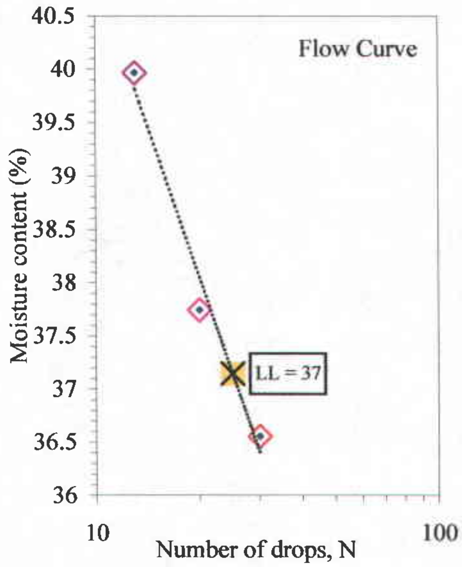
Plastic Limit

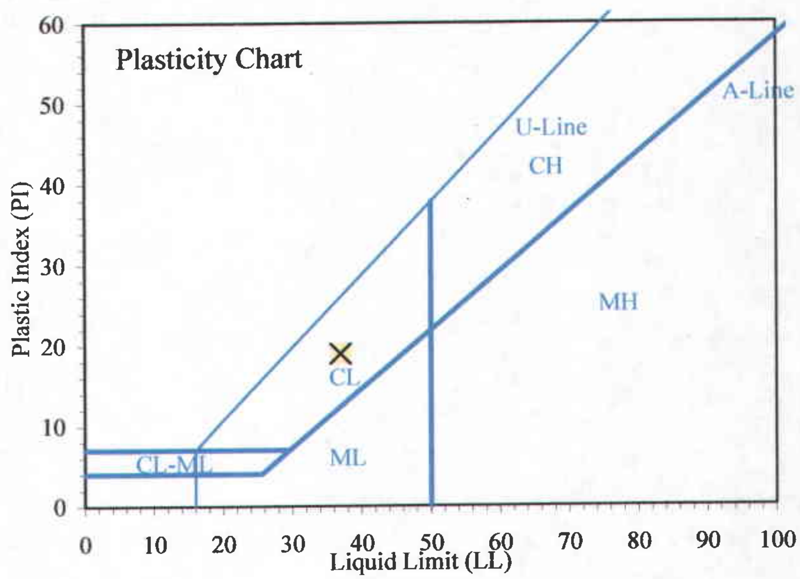
Determination No	1	2				
Wet Soil + Tare (g)	9.63	9.76				
Dry Soil + Tare (g)	8.35	8.47				
Moisture Loss (g)	1.28	1.29				
Tare (g)	1.39	1.4				
Dry Soil (g)	6.96	7.07				
Moisture Content, w (%)	18.39	18.25				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	30	20	13			
Wet Soil + Tare (g)	11	11.9	10.25			
Dry Soil + Tare (g)	8.43	9.02	7.72			
Moisture Loss (g)	2.57	2.88	2.53			
Tare (g)	1.4	1.39	1.39			
Dry Soil (g)	7.03	7.63	6.33			
Moisture Content, w (%)	36.56	37.75	39.97			
One-Point LL (%)	37	37				

Liquid Limit, LL (%)	37
Plastic Limit, PL (%)	18
Plasticity Index, PI (%)	19





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Reviewed:___________

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils
(ASTM D4318)

IGES

Project: Taylor Geo-Engineering
No: M00991-002
Location:
Date: 3/15/2007
By: NB

Boring No.: GT-3
Sample:
Depth: 30-31.5
Description: Not Requested

Preparation method: Air Dry
Liquid limit test method: Multipoint

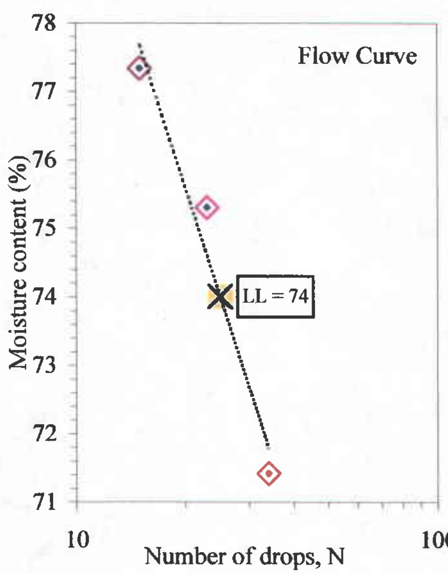
Plastic Limit

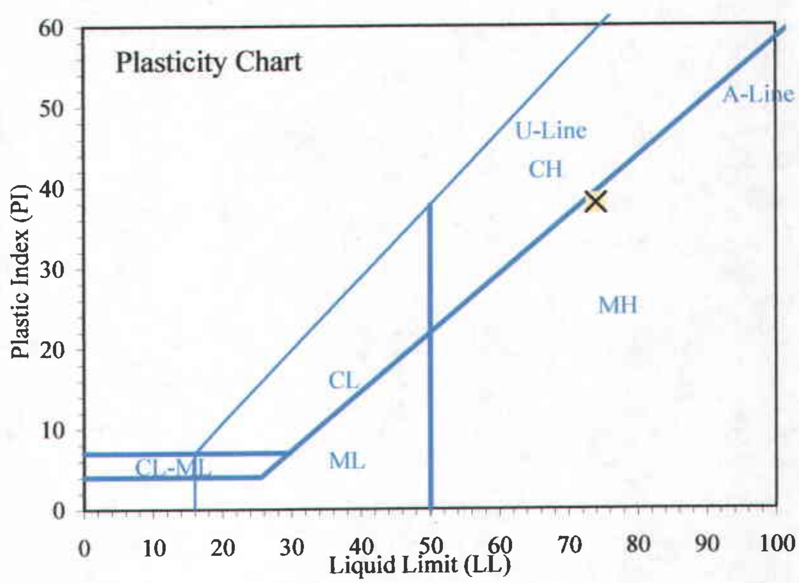
Determination No	1	2				
Wet Soil + Tare (g)	4.54	4.32				
Dry Soil + Tare (g)	3.7	3.55				
Moisture Loss (g)	0.84	0.77				
Tare (g)	1.39	1.39				
Dry Soil (g)	2.31	2.16				
Moisture Content, w (%)	36.36	35.65				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	34	23	15			
Wet Soil + Tare (g)	7.02	8.35	8.2			
Dry Soil + Tare (g)	4.67	5.36	5.23			
Moisture Loss (g)	2.35	2.99	2.97			
Tare (g)	1.38	1.39	1.39			
Dry Soil (g)	3.29	3.97	3.84			
Moisture Content, w (%)	71.43	75.31	77.34			
One-Point LL (%)		75				

Liquid Limit, LL (%)	74
Plastic Limit, PL (%)	36
Plasticity Index, PI (%)	38





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

IGES
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Project: Taylor Geo-Engineering
No: M00991-002
Location:
Date: 3/13/2007
By: BRR

Boring No.: GT-5
Sample:
Depth: 5-6.5
Description: Not Requested

Preparation method: Air Dry
Liquid limit test method: Multipoint

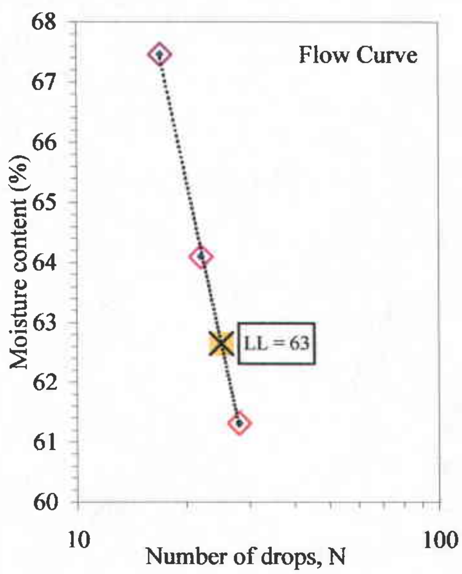
Plastic Limit

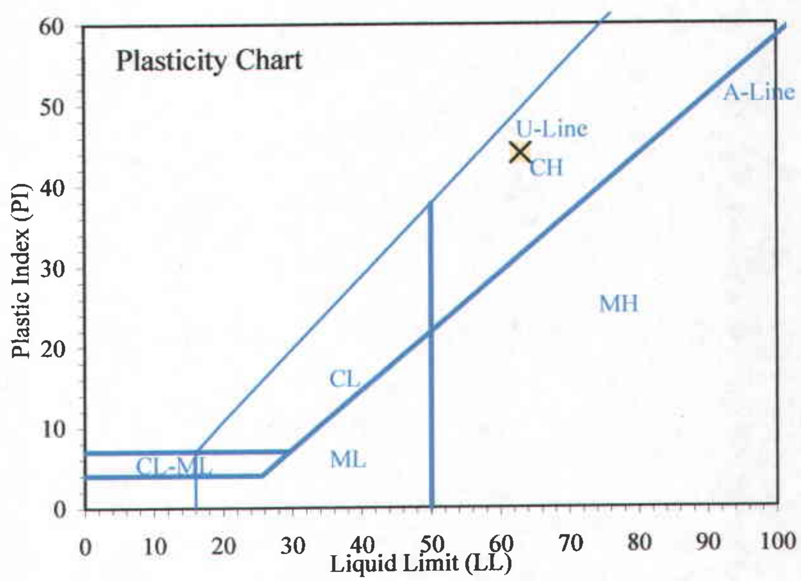
Determination No	1	2			
Wet Soil + Tare (g)	8.32	8.38			
Dry Soil + Tare (g)	7.22	7.28			
Moisture Loss (g)	1.1	1.1			
Tare (g)	1.39	1.38			
Dry Soil (g)	5.83	5.90			
Moisture Content, w (%)	18.87	18.64			

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	28	22	17			
Wet Soil + Tare (g)	9.23	8.43	10.49			
Dry Soil + Tare (g)	6.25	5.68	6.82			
Moisture Loss (g)	2.98	2.75	3.67			
Tare (g)	1.39	1.39	1.38			
Dry Soil (g)	4.86	4.29	5.44			
Moisture Content, w (%)	61.32	64.10	67.46			
One-Point LL (%)	62	63				

Liquid Limit, LL (%)	**63**
Plastic Limit, PL (%)	**19**
Plasticity Index, PI (%)	**44**





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

IGES

Project: .
No: M00991-002
Location:
Date: 3/15/2007
By: NB

Boring No.: GT-5
Sample:
Depth: 10-11.5
Description: Not Requested

Preparation method: Air Dry
Liquid limit test method: Multipoint

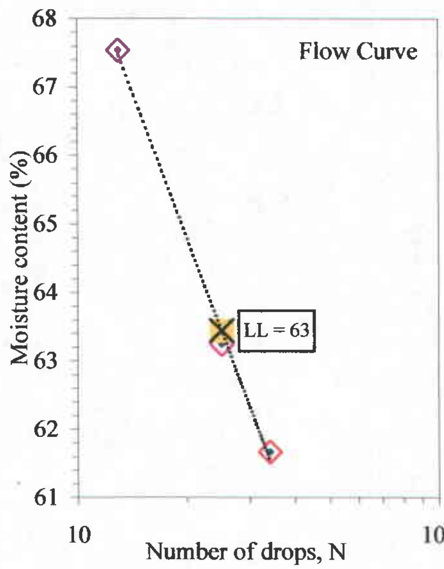
Plastic Limit

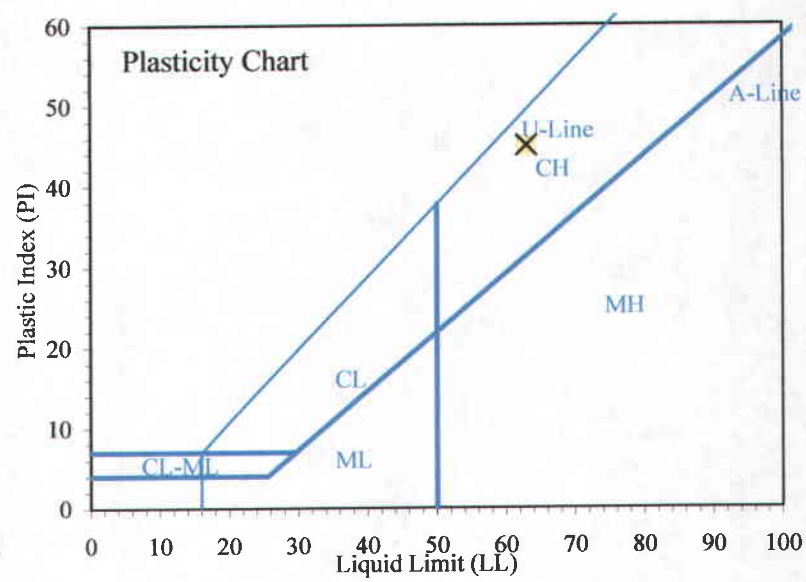
Determination No	1	2				
Wet Soil + Tare (g)	5.3	5.18				
Dry Soil + Tare (g)	4.7	4.61				
Moisture Loss (g)	0.6	0.57				
Tare (g)	1.35	1.35				
Dry Soil (g)	3.35	3.26				
Moisture Content, w (%)	17.91	17.48				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	34	25	13			
Wet Soil + Tare (g)	8.93	8.19	10.32			
Dry Soil + Tare (g)	6.05	5.54	6.72			
Moisture Loss (g)	2.88	2.65	3.6			
Tare (g)	1.38	1.35	1.39			
Dry Soil (g)	4.67	4.19	5.33			
Moisture Content, w (%)	61.67	63.25	67.54			
One-Point LL (%)		63				

Liquid Limit, LL (%)	63
Plastic Limit, PL (%)	18
Plasticity Index, PI (%)	45





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Amount of Material in Soil Finer than the No. 200 (75µm) Sieve

(ASTM D1140)

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Project: Taylor Geo-Engineering
No: M00991-002
Location:
Date: 3/12/2007
By: NB

Sample Info.	Boring No.	GT-2	GT-3						
	Sample								
	Depth	10-11.5	10-11.5						
	Split	No	No						
	Split Sieve*								
	Moist total sample wt. (g)	298.34	352.37						
	Moist coarse fraction (g)								
	Dry split fraction (g)								
	No. 200 Dry wt. retained (g)	179.78	198.58						
	Split sieve* Dry wt. retained (g)								
	Dry total sample wt. (g)	269.64	317.54						
Coarse Fraction	Moist soil + tare (g)								
	Dry soil + tare (g)								
	Tare (g)								
	Moisture content (%)								
Split Fraction	Moist soil + tare (g)	438.87	492.21						
	Dry soil + tare (g)	410.17	457.38						
	Tare (g)	140.53	139.84						
	Moisture content (%)	10.64	10.97						
	Percent passing split sieve* (%)								
	Percent passing No. 200 sieve (%)	**33.3**	**37.5**						

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Unconfined Compressive Strength of Cohesive Soils

(ASTM D2166)

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Project: Taylor Geo-Engineering

No: M00991-002

Location:

Date: 3/13/2007

By: DS

Boring No.: GT-1

Sample:

Depth: 25-26.5 feet

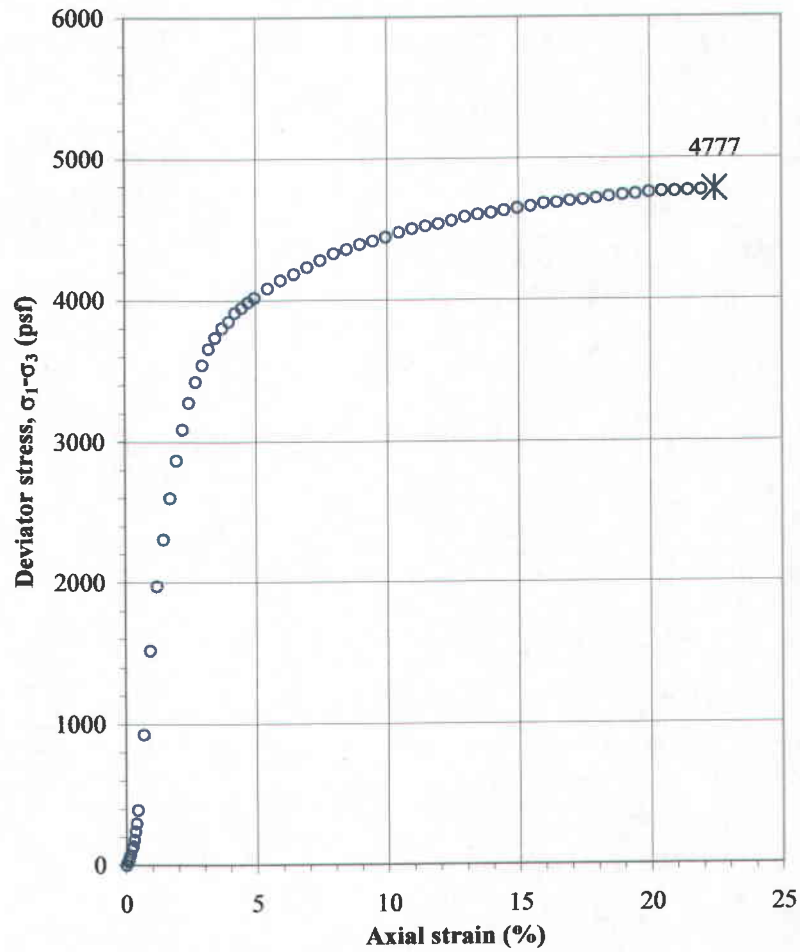
Sample Description: Brown clay

Sample type: Undisturbed

Sample height, H (in.)	4.250
Sample diameter, D (in.)	1.930
Sample volume, V (ft^3)	0.0072
Wt. rings + wet soil (g)	398.84
Wt. rings/tare (g)	0.00
Moist soil, Ws (g)	398.84
Moist unit wt., γ_m (pcf)	122.2
Dry unit wt., γ_d (pcf)	**95.0**

Wet soil + tare (g)	58.32
Dry soil + tare (g)	52.02
Tare (g)	30.00
Moisture content, w (%)	**28.6**
Strain rate (%/min)	2.0
Strain at failure, ε_f (%)	22.45
Deviator stress at failure, $(\sigma1-\sigma3)_f$ (psf)	4777
Shear stress at failure, $q_f = (\sigma1_f-\sigma3_f)/2$ (psf)	2389

Axial Strain (%)	σd σ1-σ3 (psf)	Q 1/2 σd (psf)
0.00	0.0	0.0
0.05	25.8	12.9
0.10	45.1	22.6
0.15	70.9	35.5
0.20	116.0	58.0
0.26	135.3	67.6
0.31	180.3	90.1
0.35	238.2	119.1
0.40	296.0	148.0
0.46	392.4	196.2
0.70	924.5	462.3
0.95	1517.9	759.0
1.20	1974.2	987.1
1.46	2306.7	1153.4
1.70	2599.6	1299.8
1.95	2865.6	1432.8
2.20	3085.8	1542.9
2.45	3273.3	1636.7
2.70	3422.1	1711.1
2.95	3538.6	1769.3
3.20	3654.4	1827.2
3.45	3732.2	1866.1
3.71	3802.9	1901.5
3.95	3849.0	1924.5
4.20	3913.2	1956.6
4.45	3945.9	1973.0
4.70	3984.5	1992.3
4.95	4017.0	2008.5
5.46	4080.6	2040.3
5.95	4137.8	2068.9
6.45	4181.8	2090.9
6.95	4231.2	2115.6
7.46	4279.4	2139.7
7.96	4326.8	2163.4
8.45	4356.5	2178.3
8.96	4390.9	2195.5
9.45	4413.3	2206.7
9.95	4440.9	2220.5
10.45	4473.4	2236.7
10.96	4499.5	2249.8
11.46	4519.5	2259.8
11.95	4533.5	2266.8
12.45	4558.1	2279.1
12.95	4582.0	2291.0
13.45	4600.0	2300.0
13.95	4611.5	2305.8
14.45	4628.5	2314.3
14.95	4644.9	2322.5
15.46	4654.9	2327.5
15.96	4675.7	2337.9
16.45	4680.0	2340.0
16.96	4693.8	2346.9
17.45	4702.7	2351.4
17.95	4710.8	2355.4
18.45	4723.6	2361.8
18.96	4735.4	2367.7
19.45	4742.6	2371.3
19.96	4753.5	2376.8
20.46	4759.2	2379.6
20.96	4759.2	2379.6
21.45	4764.2	2382.1
21.95	4768.7	2384.4
22.45	4777.3	2388.7



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Unconfined Compressive Strength of Cohesive Soils

(ASTM D2166)

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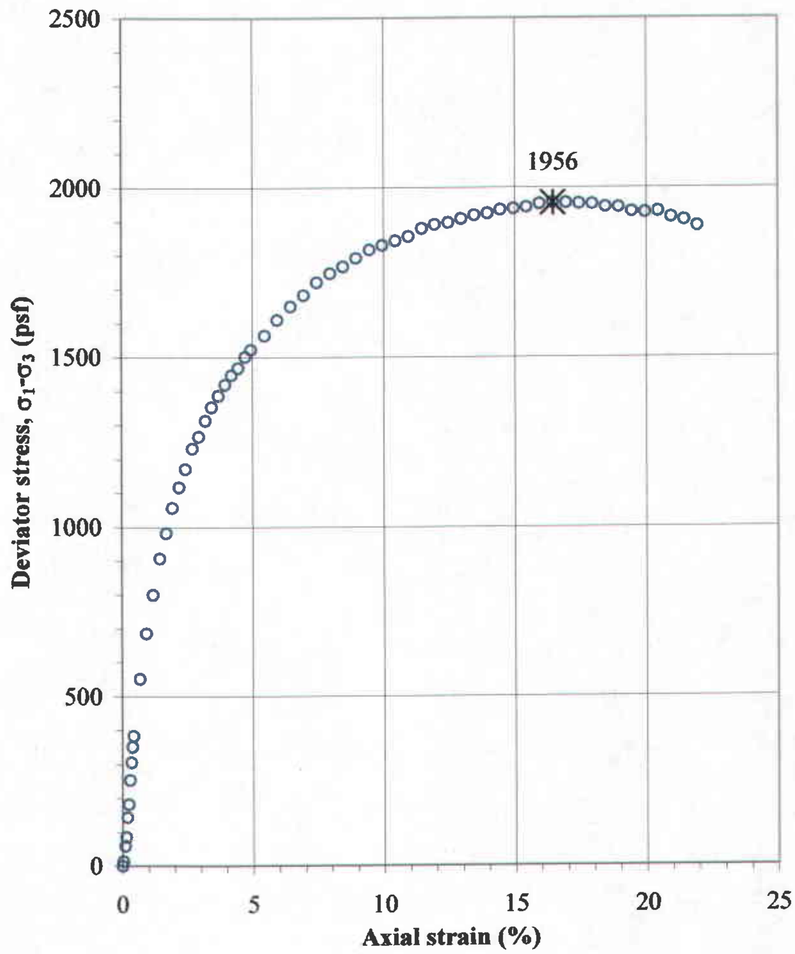
Project: Taylor Geo-Engineering
No: M00991-002
Location:
Date: 3/13/2007
By: DS

Boring No.: GT-3
Sample:
Depth: 30-31.5 feet
Sample Description: Dark grey clay with organics
Sample type: Undisturbed

Sample height, H (in.)	4.200
Sample diameter, D (in.)	1.920
Sample volume, V (ft^3)	0.0070
Wt. rings + wet soil (g)	335.60
Wt. rings/tare (g)	0.00
Moist soil, Ws (g)	335.60
Moist unit wt., γ_m (pcf)	105.1
Dry unit wt., γ_d (pcf)	**76.6**

Wet soil + tare (g)	70.62
Dry soil + tare (g)	59.53
Tare (g)	29.82
Moisture content, w (%)	**37.3**
Strain rate (%/min)	2.0
Strain at failure, ε_f (%)	16.45
Deviator stress at failure, $(\sigma 1-\sigma 3)_f$ (psf)	1956
Shear stress at failure, $q_f = (\sigma 1_f - \sigma 3_f)/2$ (psf)	978

Axial Strain (%)	σd σ1-σ3 (psf)	Q 1/2 σd (psf)
0.00	0.0	0.0
0.04	13.0	6.5
0.10	58.7	29.3
0.14	84.7	42.3
0.20	143.3	71.7
0.25	182.3	91.2
0.29	253.9	126.9
0.35	305.8	152.9
0.39	351.2	175.6
0.44	383.5	191.7
0.69	551.0	275.5
0.94	685.3	342.7
1.19	799.6	399.8
1.45	906.6	453.3
1.69	981.2	490.6
1.94	1055.3	527.7
2.19	1116.3	558.2
2.44	1170.4	585.2
2.70	1230.6	615.3
2.95	1265.3	632.7
3.20	1312.3	656.2
3.44	1352.8	676.4
3.69	1386.8	693.4
3.94	1420.5	710.3
4.19	1447.8	723.9
4.44	1468.7	734.4
4.71	1501.5	750.8
4.94	1522.4	761.2
5.45	1563.1	781.6
5.94	1609.7	804.9
6.44	1649.4	824.7
6.94	1682.4	841.2
7.45	1721.0	860.5
7.95	1747.0	873.5
8.44	1767.0	883.5
8.94	1792.3	896.2
9.45	1817.0	908.5
9.94	1830.0	915.0
10.44	1842.6	921.3
10.94	1854.9	927.5
11.45	1878.3	939.2
11.94	1890.0	945.0
12.45	1895.6	947.8
12.94	1907.0	953.5
13.45	1917.7	958.9
13.94	1923.0	961.5
14.44	1933.5	966.8
14.94	1938.0	969.0
15.44	1942.6	971.3
15.94	1952.2	976.1
16.45	1956.0	978.0
16.95	1954.5	977.3
17.44	1952.8	976.4
17.94	1950.9	975.5
18.45	1943.5	971.8
18.94	1941.4	970.7
19.44	1928.7	964.4
19.95	1926.2	963.1
20.44	1929.2	964.6
20.94	1911.1	955.6
21.44	1903.2	951.6
21.94	1885.3	942.7
22.44	1862.2	931.1



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Unconfined Compressive Strength of Cohesive Soils

(ASTM D2166)

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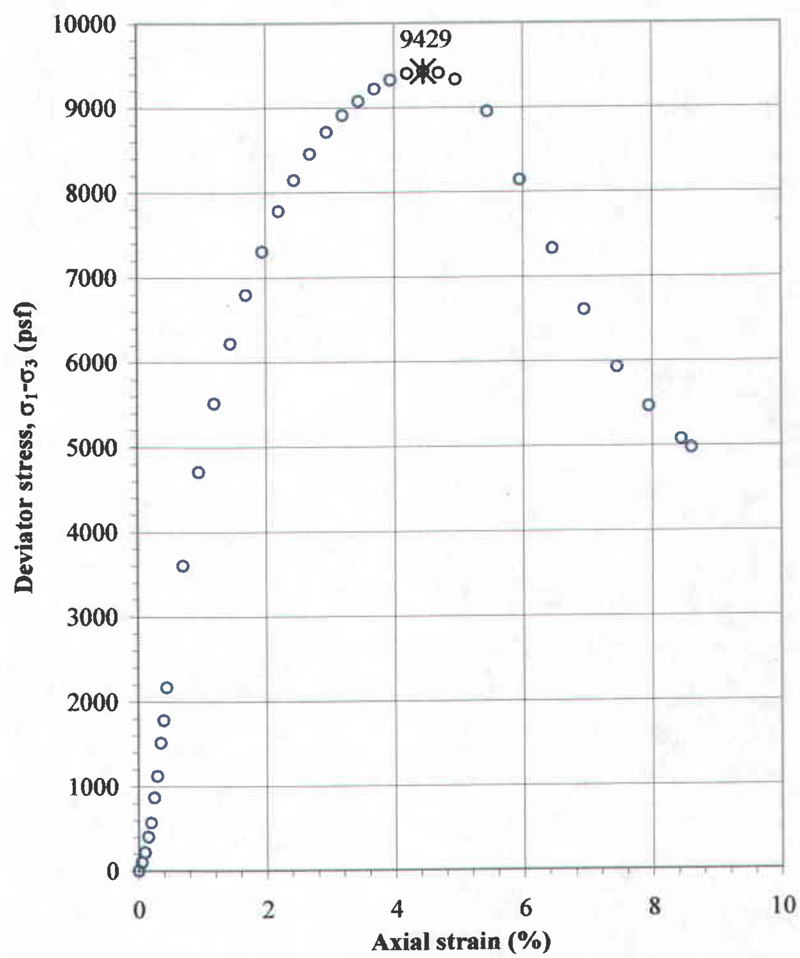
Project: Taylor Geo-Engineering
No: M00991-002
Location:
Date: 3/13/2007
By: DS

Boring No.: GT-5
Sample:
Depth: 10-11.5 feet
Sample Description: Brown clay
Sample type: Undisturbed

Sample height, H (in.)	5.990
Sample diameter, D (in.)	2.416
Sample volume, V (ft^3)	0.0159
Wt. rings + wet soil (g)	860.41
Wt. rings/tare (g)	0.00
Moist soil, Ws (g)	860.41
Moist unit wt., γ_m (pcf)	119.4
Dry unit wt., γ_d (pcf)	**102.0**

Wet soil + tare (g)	339.46
Dry soil + tare (g)	315.83
Tare (g)	177.29
Moisture content, w (%)	**17.1**
Strain rate (%/min)	2.0
Strain at failure, ε_f (%)	4.45
Deviator stress at failure, $(\sigma 1-\sigma 3)_f$ (psf)	9429
Shear stress at failure, $q_f = (\sigma 1_f-\sigma 3_f)/2$ (psf)	4714

Axial Strain (%)	σd σ1-σ3 (psf)	Q 1/2 σd (psf)
0.00	0.0	0.0
0.05	99.0	49.5
0.10	218.5	109.3
0.15	403.9	202.0
0.20	572.6	286.3
0.25	873.0	436.5
0.29	1127.8	563.9
0.35	1517.9	759.0
0.40	1784.5	892.3
0.45	2170.0	1085.0
0.70	3603.3	1801.7
0.95	4706.5	2353.3
1.20	5518.7	2759.4
1.45	6224.8	3112.4
1.69	6797.6	3398.8
1.95	7306.2	3653.1
2.20	7783.5	3891.8
2.45	8146.6	4073.3
2.69	8455.0	4227.5
2.95	8713.1	4356.6
3.20	8910.5	4455.3
3.44	9074.9	4537.5
3.69	9222.1	4611.1
3.95	9324.7	4662.4
4.20	9402.2	4701.1
4.45	9428.7	4714.4
4.70	9408.4	4704.2
4.95	9331.8	4665.9
5.44	8951.0	4475.5
5.95	8141.6	4070.8
6.45	7332.5	3666.3
6.94	6609.4	3304.7
7.45	5931.0	2965.5
7.94	5465.3	2732.7
8.45	5072.0	2536.0
8.61	4972.3	2486.2



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APPENDIX C-2

LABORATORY TESTING DATA for SAMPLES SETS
SP-16-13
CH-1-3
CH-5-48
CH-5-98

Liquid Limit, Plastic Limit, and Plasticity Index of Soils
(ASTM D4318)

IGES

Project:	Taylor Geo-Engineering	Boring No.:	_
No:	M00991-001	Sample:	CH-5-98
Location:	_	Depth:	_
Date:	3/8/2007	Description:	Gray Weathered Claystone
By:	DKS		

Preparation method: Air Dry
Liquid limit test method: Multipoint

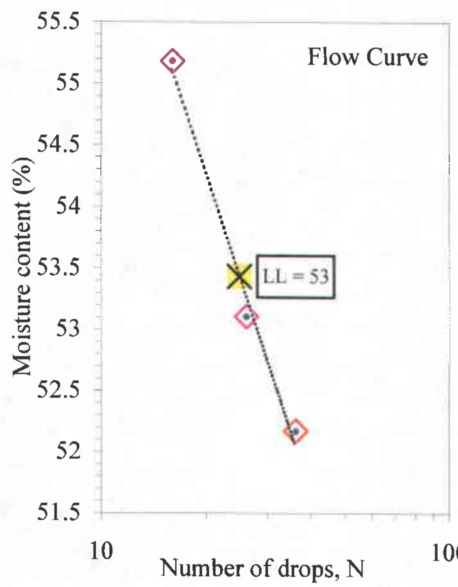
Plastic Limit

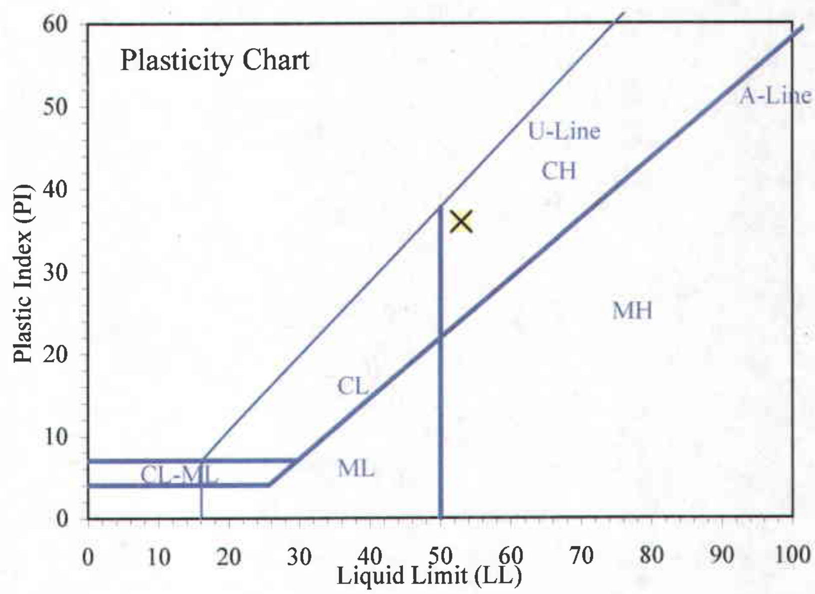
Determination No	1	2				
Wet Soil + Tare (g)	8.38	12.66				
Dry Soil + Tare (g)	7.37	10.99				
Moisture Loss (g)	1.01	1.67				
Tare (g)	1.39	1.38				
Dry Soil (g)	5.98	9.61				
Moisture Content, w (%)	16.89	17.38				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	36	26	16			
Wet Soil + Tare (g)	11.22	12.94	11.57			
Dry Soil + Tare (g)	7.85	8.92	7.95			
Moisture Loss (g)	3.37	4.02	3.62			
Tare (g)	1.39	1.35	1.39			
Dry Soil (g)	6.46	7.57	6.56			
Moisture Content, w (%)	52.17	53.10	55.18			
One-Point LL (%)		53				

Liquid Limit, LL (%)	**53**
Plastic Limit, PL (%)	**17**
Plasticity Index, PI (%)	**36**





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

IGES

Project: Taylor Geo-Engineering
No: M00991-001
Location: _
Date: 3/8/2007
By: BRR

Boring No.: _
Sample: SP-16-13
Depth: _
Description: Not Requested

Preparation method: Air Dry
Liquid limit test method: Multipoint

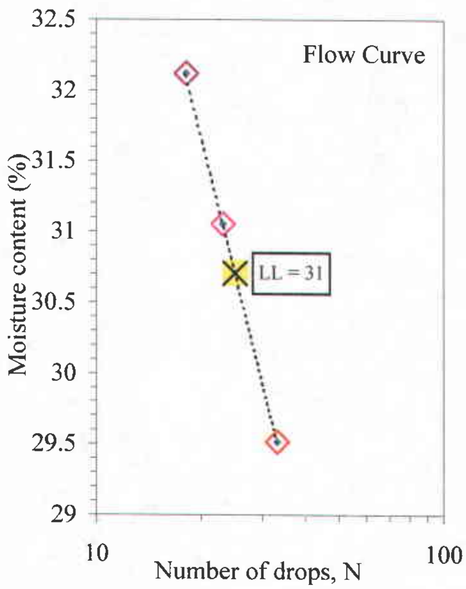
Plastic Limit

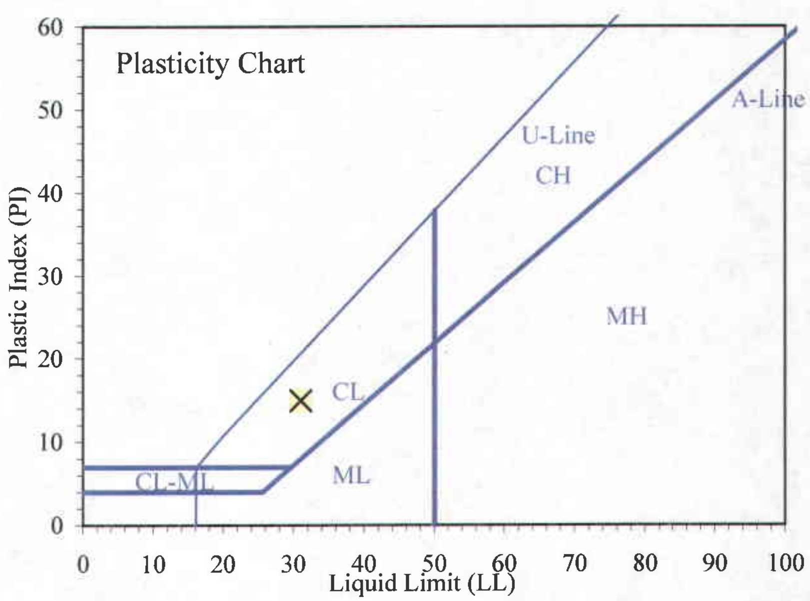
Determination No	1	2				
Wet Soil + Tare (g)	12	12.16				
Dry Soil + Tare (g)	10.53	10.66				
Moisture Loss (g)	1.47	1.5				
Tare (g)	1.4	1.39				
Dry Soil (g)	9.13	9.27				
Moisture Content, w (%)	16.10	16.18				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	33	23	18			
Wet Soil + Tare (g)	9.64	10.95	10.77			
Dry Soil + Tare (g)	7.76	8.68	8.48			
Moisture Loss (g)	1.88	2.27	2.29			
Tare (g)	1.39	1.37	1.35			
Dry Soil (g)	6.37	7.31	7.13			
Moisture Content, w (%)	29.51	31.05	32.12			
One-Point LL (%)		31				

Liquid Limit, LL (%)	**31**
Plastic Limit, PL (%)	**16**
Plasticity Index, PI (%)	**15**





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils
(ASTM D4318)

Project: Taylor Geo-Engineering
No: M00991-001
Location:
Date: 3/12/2007
By: NB

Boring No.:
Sample: CH-1-3
Depth:
Description: Not Requested

Preparation method: Air Dry
Liquid limit test method: Multipoint

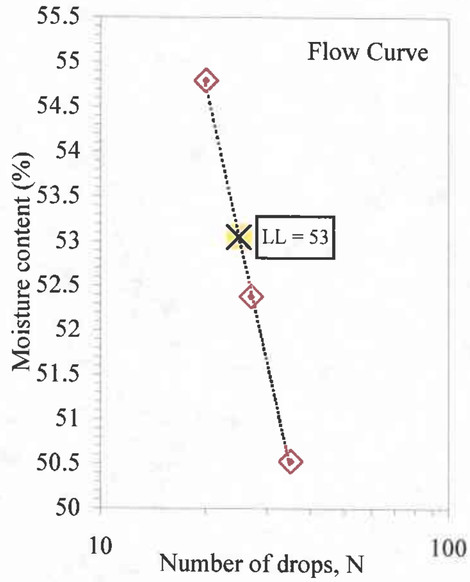
Plastic Limit

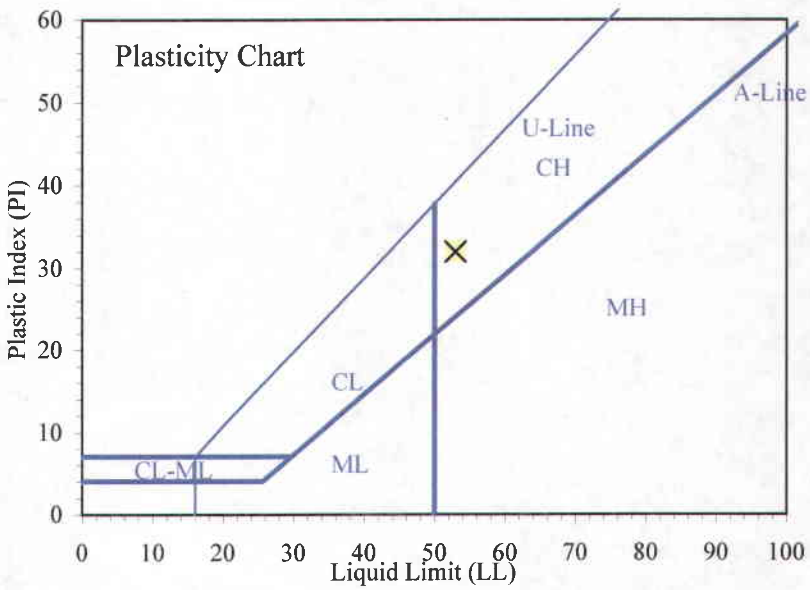
Determination No	1	2				
Wet Soil + Tare (g)	6.44	6.43				
Dry Soil + Tare (g)	5.57	5.57				
Moisture Loss (g)	0.87	0.86				
Tare (g)	1.38	1.39				
Dry Soil (g)	4.19	4.18				
Moisture Content, w (%)	20.76	20.57				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	35	27	20			
Wet Soil + Tare (g)	8.47	8.11	10.61			
Dry Soil + Tare (g)	6.09	5.8	7.35			
Moisture Loss (g)	2.38	2.31	3.26			
Tare (g)	1.38	1.39	1.4			
Dry Soil (g)	4.71	4.41	5.95			
Moisture Content, w (%)	50.53	52.38	54.79			
One-Point LL (%)		53	53			

Liquid Limit, LL (%)	**53**
Plastic Limit, PL (%)	**21**
Plasticity Index, PI (%)	**32**





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Liquid Limit, Plastic Limit, and Plasticity Index of Soils
(ASTM D4318)

IGES

Project: Taylor Geo-Engineering
No: M00991-001
Location:
Date: 3/12/2007
By: NB

Boring No.:
Sample: CH-5-48
Depth:
Description: Not Requested

Preparation method: Air Dry
Liquid limit test method: Multipoint

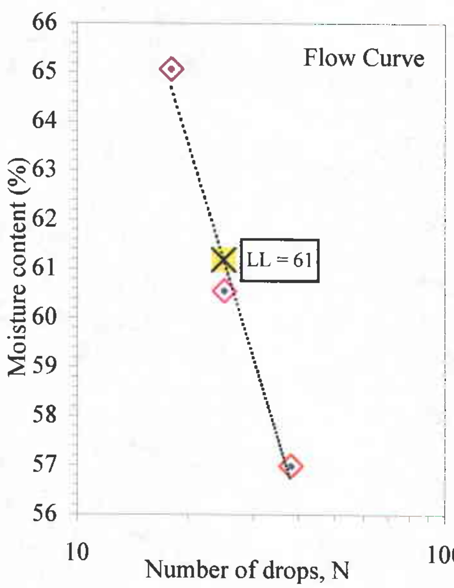
Plastic Limit

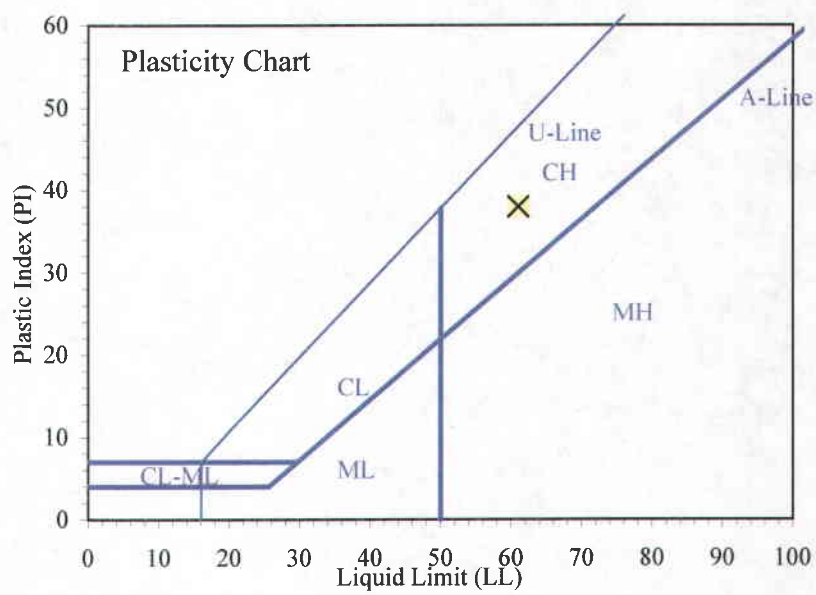
Determination No	1	2				
Wet Soil + Tare (g)	8.58	10.39				
Dry Soil + Tare (g)	7.22	8.71				
Moisture Loss (g)	1.36	1.68				
Tare (g)	1.4	1.39				
Dry Soil (g)	5.82	7.32				
Moisture Content, w (%)	23.37	22.95				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	38	25	18			
Wet Soil + Tare (g)	8.69	9	9.55			
Dry Soil + Tare (g)	6.04	6.13	6.33			
Moisture Loss (g)	2.65	2.87	3.22			
Tare (g)	1.39	1.39	1.38			
Dry Soil (g)	4.65	4.74	4.95			
Moisture Content, w (%)	56.99	60.55	65.05			
One-Point LL (%)		61				

Liquid Limit, LL (%)	**61**
Plastic Limit, PL (%)	**23**
Plasticity Index, PI (%)	**38**





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Particle-Size Analysis of Soils

(ASTM D422)

IGES
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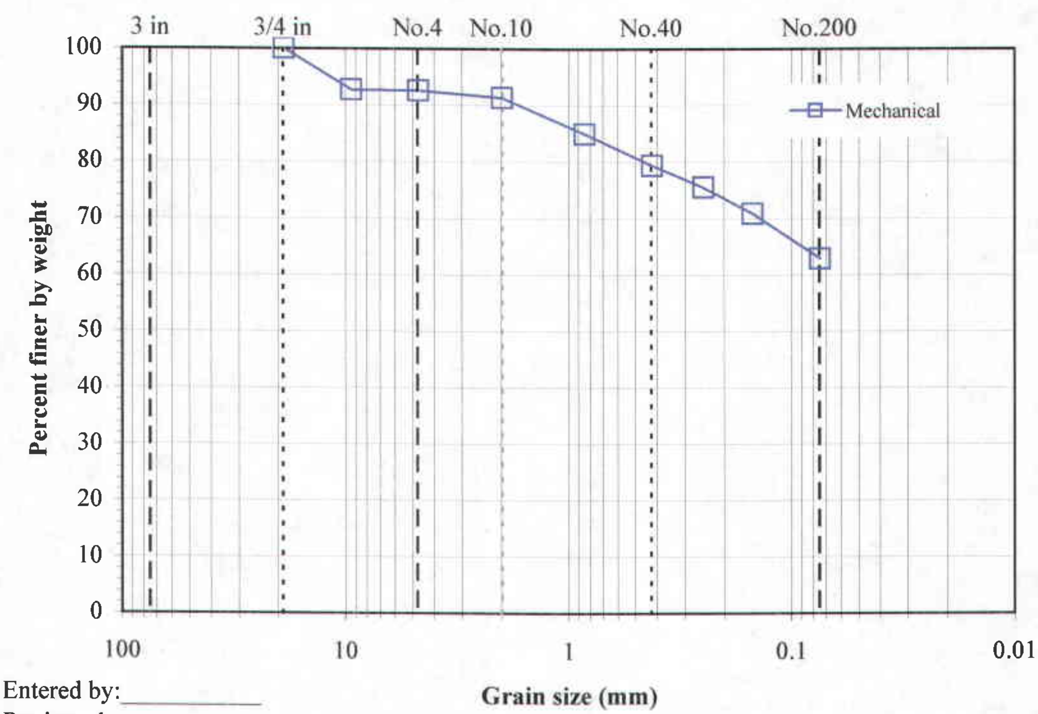
Project: Taylor Geo-Engineering
No: M00991-001
Location: __
Date: 3/6/2007
By: DKS

Boring No.: __
Sample: CH-5-98
Depth: __
Description: Gray Weathered Claystone

Split:	Yes	
Split sieve:	3/8"	
	Moist	Dry
Total sample wt. (g):	7142.6	6906.5
+3/8" Coarse fraction (g):	523.1	505.9
-3/8" Split fraction (g):	1270.1	1228.10
Split fraction:	0.927	

Moisture data	C.F.(+3/8")	S.F.(-3/8")
Moist soil + tare (g):	629.80	1661.40
Dry soil + tare (g):	616.32	1619.40
Tare (g):	220.90	391.30
Moisture content (%):	3.4	3.4

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
12"	-	300	-	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	100.0	
3/8"	505.90	9.5	92.7	←Split
No.4	1.40	4.75	92.6	
No.10	18.10	2	91.3	
No.20	102.50	0.85	84.9	
No.40	176.30	0.425	79.4	
No.60	227.20	0.25	75.5	
No.100	289.00	0.15	70.9	
No.200	394.40	0.075	62.9	



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Particle-Size Analysis of Soils
(ASTM D422)

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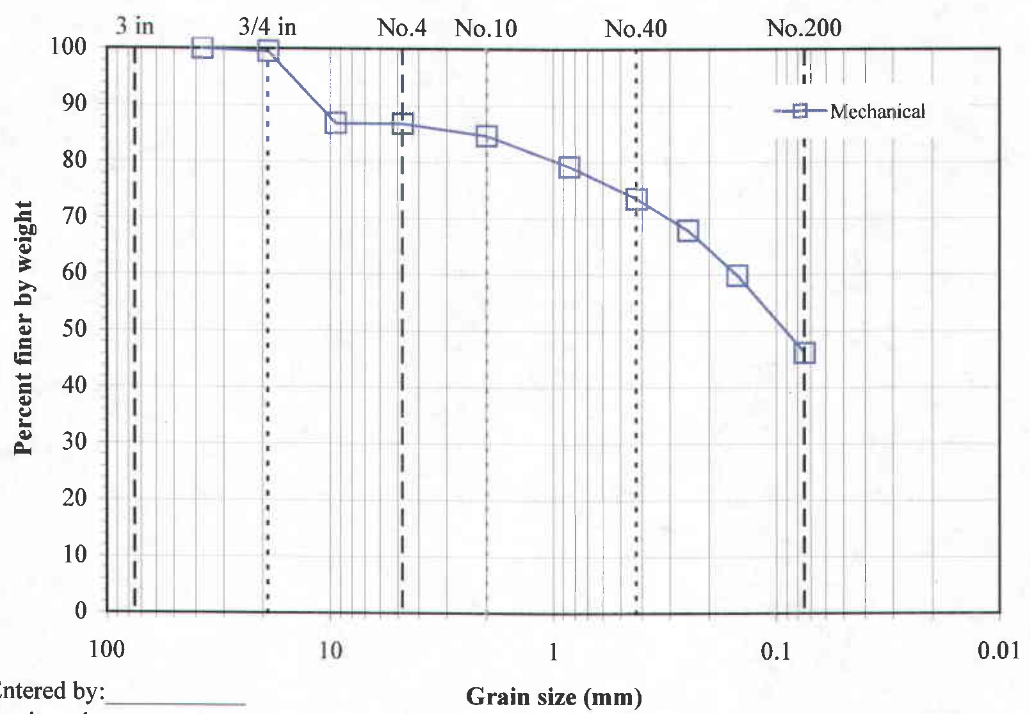
Project: Taylor Geo-Engineering
No: M00991-001
Location: __
Date: 3/6/2007
By: DKS

Boring No.: __
Sample: CH-5-48
Depth: __
Description: Gray Weathered Claystone

Split:	Yes	
Split sieve:	3/8"	
	Moist	Dry
Total sample wt. (g):	5766.1	5455.0
+3/8" Coarse fraction (g):	760.6	719.0
-3/8" Split fraction (g):	464.4	439.40
Split fraction:	0.868	

Moisture data	C.F.(+3/8")	S.F.(-3/8")
Moist soil + tare (g):	440.80	646.60
Dry soil + tare (g):	426.29	621.60
Tare (g):	175.80	182.20
Moisture content (%):	5.8	5.7

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
12"	-	300	-	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	100.0	
3/4"	27.60	19	99.5	
3/8"	719.00	9.5	86.8	←Split
No.4	0.20	4.75	86.8	
No.10	11.10	2	84.6	
No.20	38.60	0.85	79.2	
No.40	67.70	0.425	73.4	
No.60	96.10	0.25	67.8	
No.100	136.70	0.15	59.8	
No.200	205.90	0.075	46.1	



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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

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Project: Taylor Geo-Engineering
No: M00991-001
Location:
Date: 3/12/2007
By: BRR

Boring No.:
Sample: CH-1-3
Depth:
Description: Description

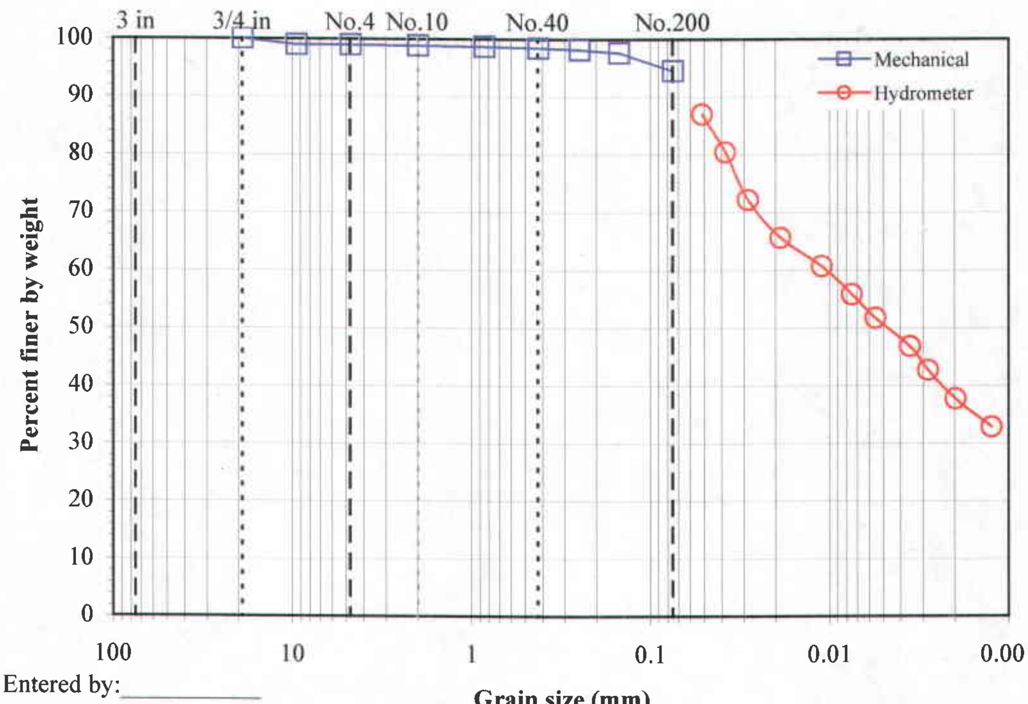
Split sieve:	Yes		
Split sieve:	3/8"		
	Moist	Dry	
Total sample wt. (g):	7774	7397.19	
+3/8" Coarse fraction (g):	83.4	79.60	
-3/8" Split fraction (g):	356.60	339.30	
Hydrometer fraction (g):	62.26	60.20	
Split fraction:	0.989		

Moisture data	C.F.(+3/8")	S.F.(-3/8")	Hyd.(-No.10)
Moist soil + tare (g):	224.40	92.06	61.75
Dry soil + tare (g):	220.60	89.05	60.70
Tare (g):	141.00	30.00	30.04
Moisture content (%):	4.77	5.10	3.42

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.164
			Intercept:	16.3
Gs:	2.65	Assumed	α:	1.00
Composite corr.:	6		Hyd. fraction:	98.81
Dispersion period (min):	15		Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
12"	-	300	-	
8"	-	200	-	
6"	-	150	-	
4"	-	100	-	
3"	-	75	-	
1.5"	-	37.5	-	
3/4"	-	19	100.0	
3/8"	79.60	9.5	98.9	<=Split
No.4	-	4.75	98.9	
No.10	0.40	2	98.8	<=Split hyd.
No.20	0.10	0.85	98.6	
No.40	0.25	0.425	98.4	
No.60	0.40	0.25	98.2	
No.100	0.75	0.15	97.6	
No.200	2.63	0.075	94.5	

Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
0.5	16.5	59	0.05190	86.99
1	16.5	55	0.03847	80.43
2	16.5	50	0.02870	72.22
5	16.5	46	0.01887	65.65
15	17	43	0.01112	60.73
34	17.5	40	0.00754	55.81
64	18	37.5	0.00557	51.70
160	19	34.5	0.00357	46.78
258	20	32	0.00282	42.68
521	21.5	29	0.00199	37.75
1396	21	26	0.00125	32.83



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Particle-Size Analysis of Soils *with hydrometer*

(ASTM D422)

IGES

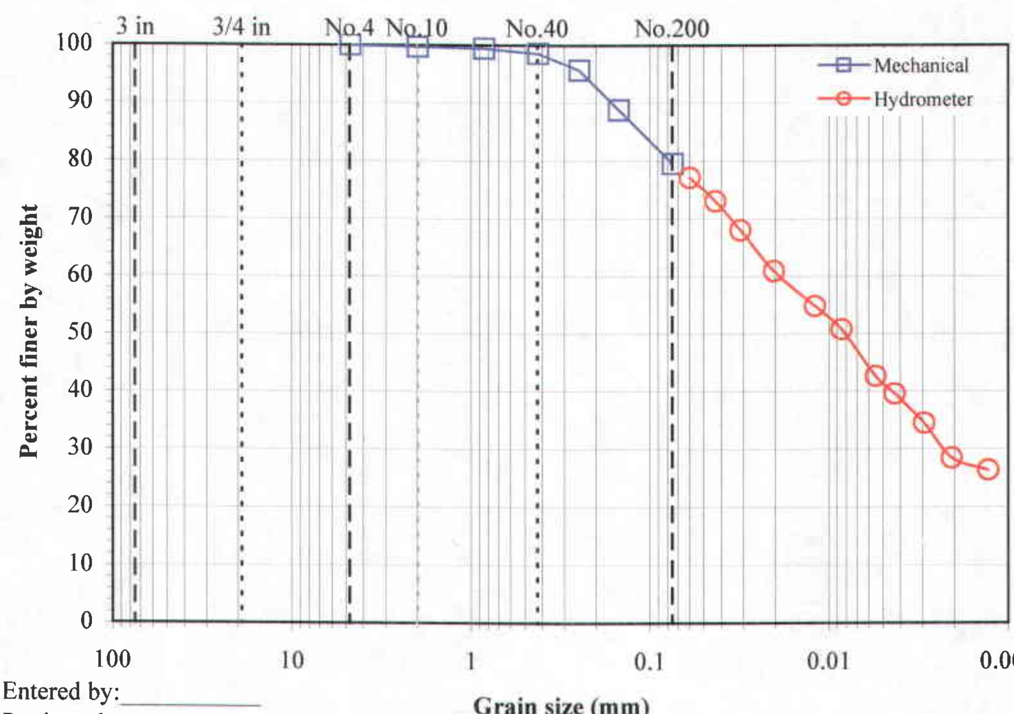
Project:	Taylor Geo-Engineering	Boring No.:	
No:	M00991-001	Sample:	SP-16-13
Location:		Depth:	
Date:	3/12/2007	Description:	Description
By:	BRR		

	Moist	Dry
Split sieve:	Yes	
Split sieve:	3/8"	
Total sample wt. (g):	10597.4	10387.95
+3/8" Coarse fraction (g):		0.00
-3/8" Split fraction (g):	511.30	501.19
Hydrometer fraction (g):	49.63	49.11
Split fraction:	1.000	

Moisture data	C.F.(+3/8")	S.F.(-3/8")	Hyd.(-No.10)
Moist soil + tare (g):	-	680.10	95.73
Dry soil + tare (g):	-	669.71	95.04
Tare (g):	-	154.40	30.00
Moisture content (%):	0.00	2.02	1.06

Hydrometer data				
Hyd. split:	No.10		Slope:	-0.164
Gs:	2.65	Assumed	Intercept:	16.3
Composite corr.:	6		α:	1.00
Dispersion period (min):	15		Hyd. fraction:	99.67
			Dispersion device:	Air-jet

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer		Elapsed time (min)	Temp. (°C)	Hydrometer Reading	Grain Size (mm)	% Soil in Suspension
12"	-	300	-		0.5	17	44	0.06039	77.13
8"	-	200	-		1	17	42	0.04347	73.07
6"	-	150	-		2	17	39.5	0.03140	67.99
4"	-	100	-		5	17	36	0.02043	60.89
3"	-	75	-		15	17	33	0.01207	54.80
1.5"	-	37.5	-		30	17.5	31	0.00861	50.74
3/4"	-	19	-		76	18	27	0.00553	42.62
3/8"	-	9.5	-	<=Split	123	19	25.5	0.00434	39.58
No.4	-	4.75	100.0		266	20	23	0.00296	34.50
No.10	1.63	2	99.7	<=Split hyd.	538	21.5	20	0.00208	28.42
No.20	0.14	0.85	99.4		1413	21	19	0.00130	26.39
No.40	0.55	0.425	98.6						
No.60	1.98	0.25	95.7						
No.100	5.36	0.15	88.8						
No.200	9.94	0.075	79.5						



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Laboratory Compaction Characteristics of Soil
(ASTM D698 / D1557)

IGES

Project: Taylor Geo-Engineering
No: M00991-001
Location:
Date: 3/1/2007
By: NB

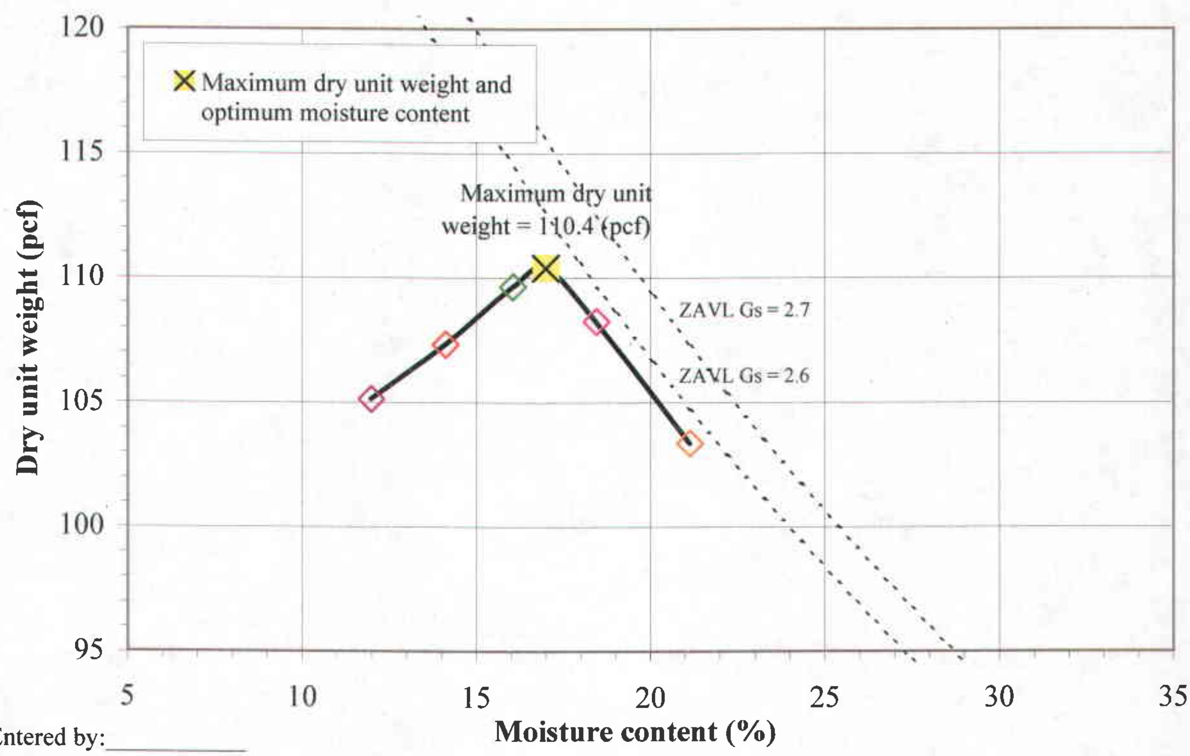
Boring No.:
Sample: SP-16-13
Depth:
Sample Description:
Engineering Classification: Not requested
As-received moisture content (%): 2.02

Method: ASTM D698 B
Mold volume (ft^3): 0.0333

Preparation method: Moist
Rammer: Mechanical-circular face
Rock Correction: No

Optimum moisture content (%): 17
Maximum dry unit weight (pcf): 110.4

Point Number	+10	+12	+14	+16	+18			
Wt. Sample + Mold (g)	5962.0	6033.3	6106.0	6120.3	6075.2			
Wt. of Mold (g)	4181.8	4181.8	4181.8	4181.8	4181.8			
Wet Unit Wt., γ_m (pcf)	117.7	122.5	127.3	128.2	125.2			
Wet Soil + Tare (g)	738.9	593.5	820.4	685.7	719			
Dry Soil + Tare (g)	674.85	538.79	728.12	602.71	620.21			
Tare (g)	140	150.7	153.3	152.4	152.7			
Moisture Content, w (%)	12.0	14.1	16.1	18.4	21.1			
Dry Unit Wt., γ_d (pcf)	105.1	107.3	109.7	108.3	103.4			



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Laboratory Compaction Characteristics of Soil

(ASTM D698 / D1557)

IGES

Project: Taylor Geo-Engineering
No: M00991-001
Location:
Date: 3/7/2007
By: DKS

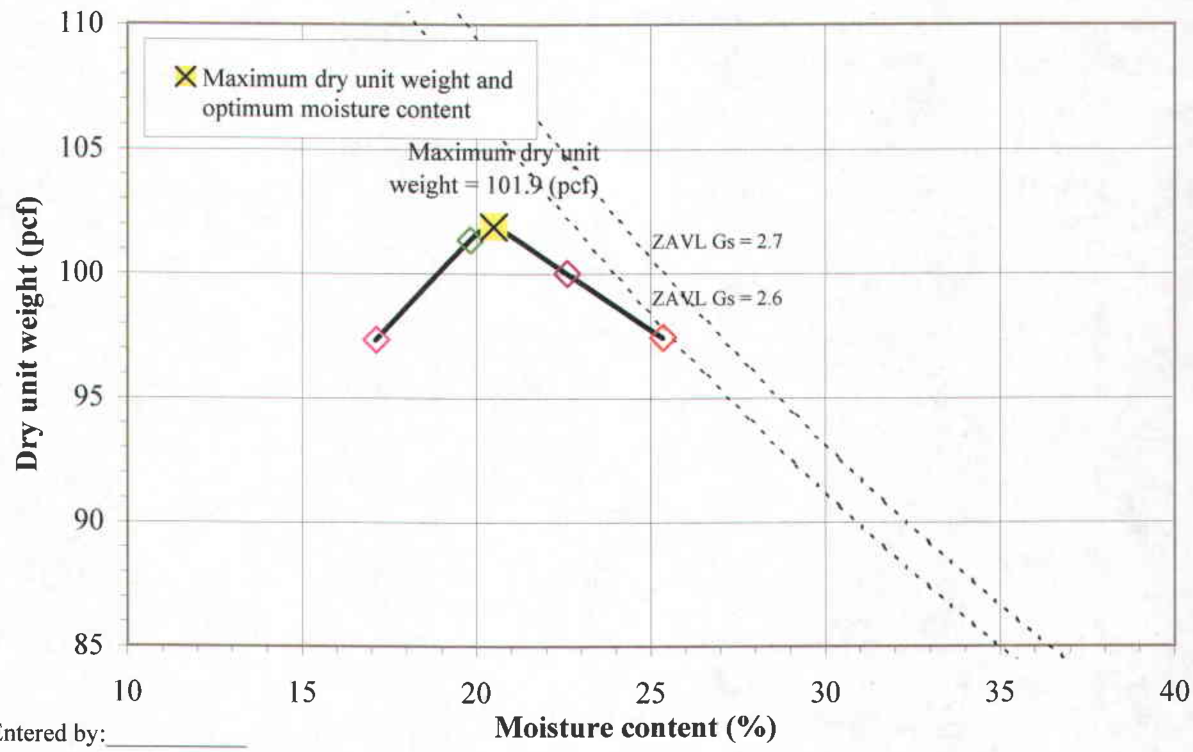
Boring No.:
Sample: CH-1-3
Depth:
Sample Description:
Engineering Classification: Not requested
As-received moisture content (%): 5.1

Method: ASTM D698 B
Mold volume (ft^3): 0.0333

Preparation method: Moist
Rammer: Mechanical-circular face
Rock Correction: No

Optimum moisture content (%): 20.5
Maximum dry unit weight (pcf): 101.9

Point Number	+18	+20	+15	+12				
Wt. Sample + Mold (g)	6110.0	6102.8	6092.8	5905.3				
Wt. of Mold (g)	4256.2	4256.2	4256.2	4181.7				
Wet Unit Wt., γ_m (pcf)	122.6	122.1	121.5	114.0				
Wet Soil + Tare (g)	518.1	584.4	626.4	659.3				
Dry Soil + Tare (g)	455.42	511.67	559.49	586.02				
Tare (g)	177.9	224.6	222	150.7				
Moisture Content, w (%)	22.6	25.3	19.8	17.1				
Dry Unit Wt., γ_d (pcf)	100.0	97.4	101.4	97.3				



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Laboratory Compaction Characteristics of Soil

(ASTM D698 / D1557)

IGES

Project: Taylor Geo-Engineering
No: M00991-001
Location:
Date: 3/7/2007
By: DKS

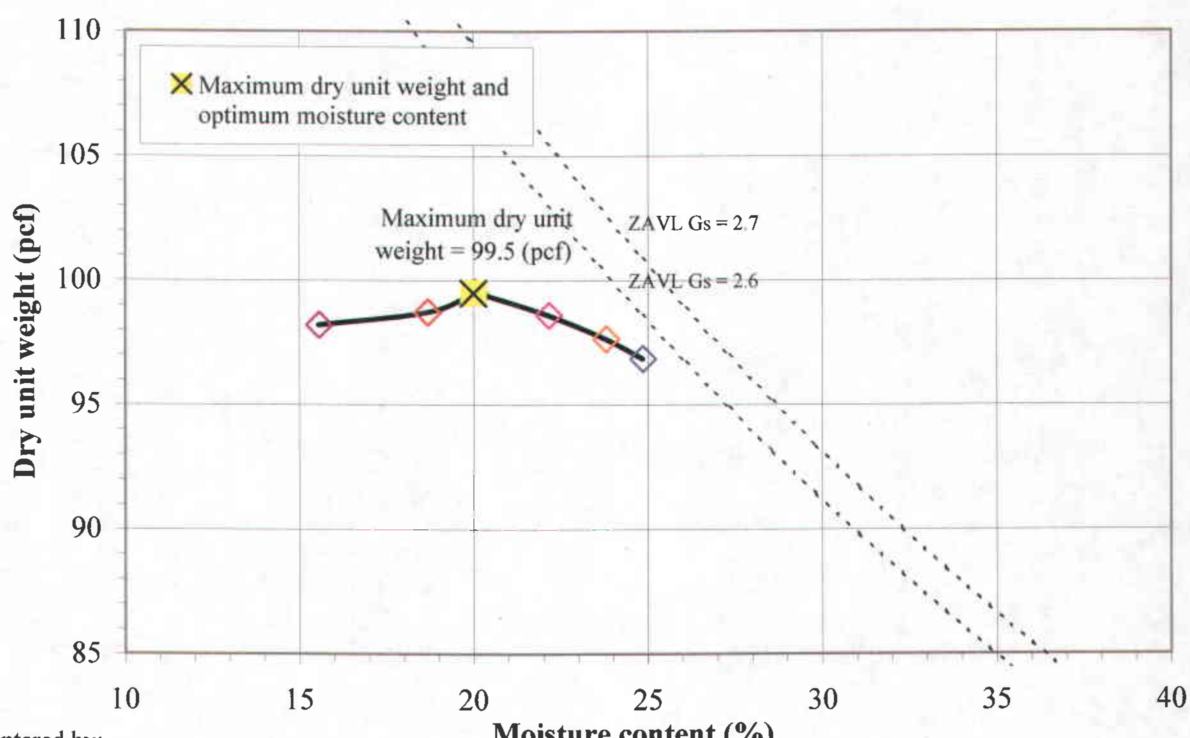
Boring No.:
Sample: CH-5-48
Depth:
Sample Description:
Engineering Classification: Not requested
As-received moisture content (%): 5.7

Method: ASTM D698 B
Mold volume (ft^3): 0.0333

Preparation method: Moist
Rammer: Mechanical-circular face
Rock Correction: No

Optimum moisture content (%): 20
Maximum dry unit weight (pcf): 99.5

Point Number	+10	+12	+14	+16	+18	+20		
Wt. Sample + Mold (g)	5890.6	5946.0	5981.3	5995.8	6002.4	6002.8		
Wt. of Mold (g)	4174.8	4174.8	4174.8	4174.8	4174.8	4174.8		
Wet Unit Wt., γ_m (pcf)	113.5	117.1	119.5	120.4	120.9	120.9		
Wet Soil + Tare (g)	360.7	316.6	348.1	376.2	414.5	450.5		
Dry Soil + Tare (g)	331.24	288.78	313.48	335.73	364.49	391.25		
Tare (g)	141.8	139.8	140.6	153	154.3	152.8		
Moisture Content, w (%)	15.6	18.7	20.0	22.1	23.8	24.8		
Dry Unit Wt., γ_d (pcf)	98.2	98.7	99.5	98.6	97.6	96.8		



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Laboratory Compaction Characteristics of Soil

(ASTM D698 / D1557)

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Project: Taylor Geo-Engineering
No: M00991-001
Location:
Date: 3/7/2007
By: DKS

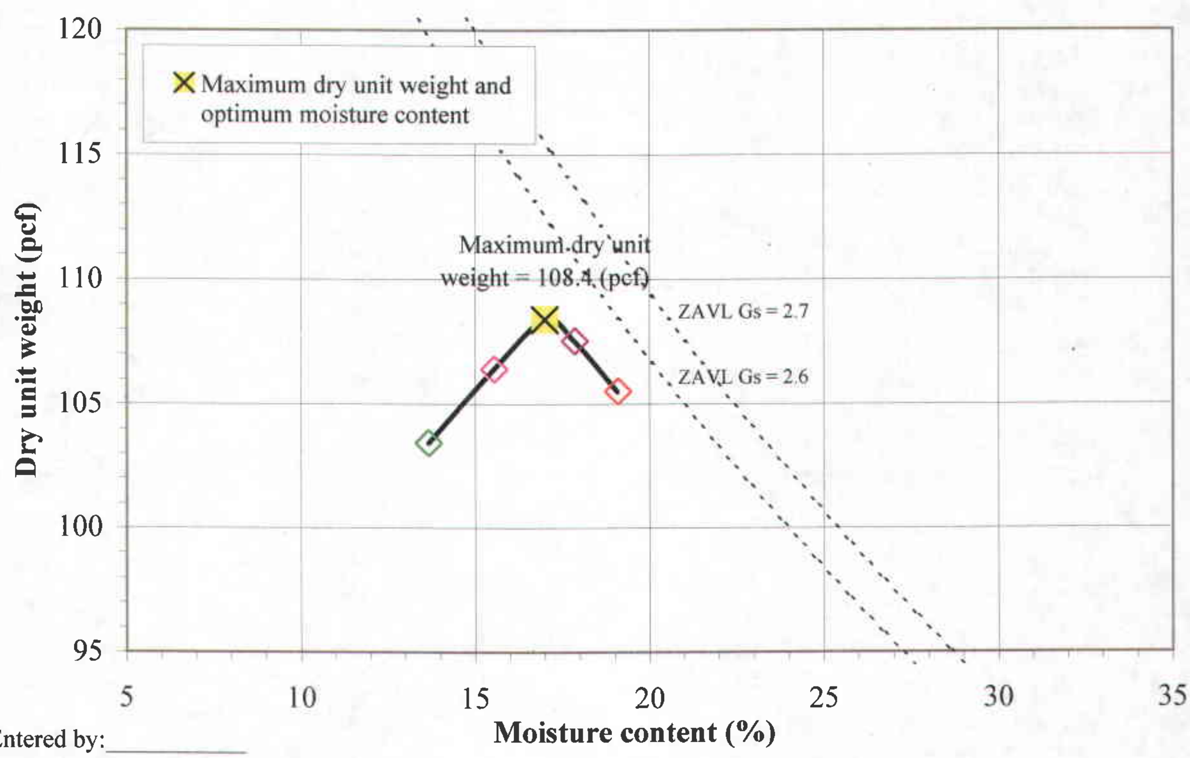
Boring No.:
Sample: CH-5-98
Depth:
Sample Description:
Engineering Classification: Not requested
As-received moisture content (%): 3.42

Method: ASTM D698 B
Mold volume (ft^3): 0.0333

Preparation method: Moist
Rammer: Mechanical-circular face
Rock Correction: No

Optimum moisture content (%): 17
Maximum dry unit weight (pcf): 108.4

Point Number	+14	+16	+10	+12				
Wt. Sample + Mold (g)	6091.4	6075.0	5952.8	6033.8				
Wt. of Mold (g)	4175.3	4175.3	4175.3	4175.3				
Wet Unit Wt., γ_m (pcf)	126.7	125.6	117.6	122.9				
Wet Soil + Tare (g)	452.1	583.3	536.3	481.8				
Dry Soil + Tare (g)	415.64	525.49	490.64	437.31				
Tare (g)	211.3	222.5	156.2	150.7				
Moisture Content, w (%)	17.8	19.1	13.7	15.5				
Dry Unit Wt., γ_d (pcf)	107.5	105.5	103.4	106.4				



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Isotropically Consolidated Undrained with Pore Pressure (CIU/PP)

Project Name: Taylor Geo-Engineering
Project Number: M00991-001
Sample: CH-1-3
Comments: Samples were compacted to 90% of ASTM D698 at OMC.

Test Number		S1	S2	S3	
Initial	Height, H (in)	5.44	5.85	5.19	
	Diameter, D (in)	2.42	2.42	2.42	
	Moisture Content, w (%)	21.0	21.0	20.2	
	Dry Unit Weight, γd (pcf)	91.0	90.9	91.4	
	Saturation (%)	66.6	66.3	64.7	
	Void Ratio, e	0.85	0.85	0.84	
Before Shear	Moisture Content, w (%)	26.5	25.1	21.2	
	Dry Unit Weight, γd (pcf)	96.4	99.3	105.8	
	Saturation (%)	100.0	100.0	100.0	
	Void Ratio, e	0.72	0.68	0.57	
	B	0.95	0.95	0.95	
	Back pressure (psf)	6193	5161	5474	
	Strain rate (%/min)	0.033	0.033	0.033	
	Time to Failure (min)	606.1	606.1	460.6	
Total Stress	Strain at Failure, εf (%)	20.00	20.00	15.20	
	σ3 (psf)	2878	5760	11518	
	σ1-σ3 (psf)	2393	3460	7111	
	σ1 (psf)	5271	9220	18629	
	q = (σ1-σ3)/2 (psf)	1197	1730	3556	
	p = (σ1+σ3)/2 (psf)	4075	7490	15073	
Effective Stress	u (psf)	1473	3782	6184	
	σ'3 (psf)	1405	1978	5334	
	σ'1-σ'3 (psf)	2393	3460	7111	
	σ'1 (psf)	3798	5438	12445	
	q = (σ'1-σ'3)/2 (psf)	1197	1730	3556	
	p' = (σ'1+σ'3)/2 (psf)	2602	3708	8889	
	σ'1/σ'3	2.70	2.75	2.33	
	A = u/(σ1−σ3)	0.616	1.093	0.870	

Estimated Specific Gravity	2.70
Plastic Limit (%)	21
Liquid Limit (%)	53
Plasticity Index (%)	32

Summary of Strength Paramaters	Total Stress	Effective Stress
c (psf)	223	319
φ (deg)	12.6	21.6
tan φ	0.224	0.396

[a] Saturation set to 100% for phase calculations

Tested by:____________

Reviewed:____________

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Isotropically Consolidated Undrained with Pore Pressure (CIU/PP)

IGES

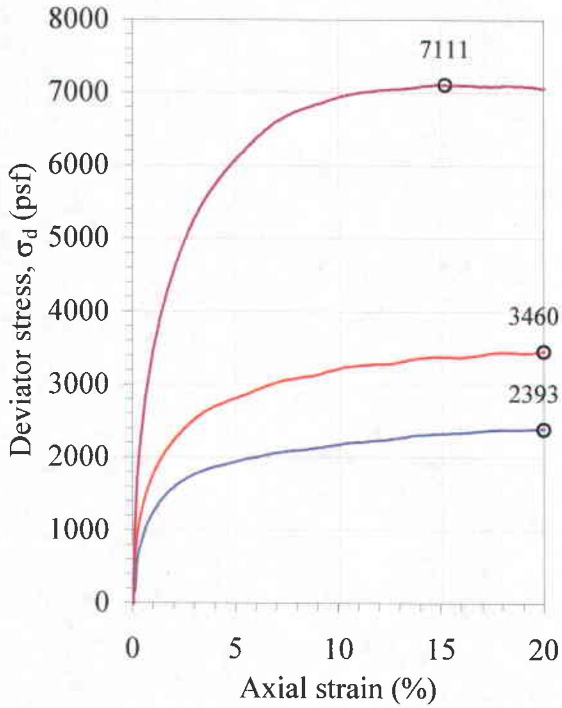
Project Name: Taylor Geo-Engineering

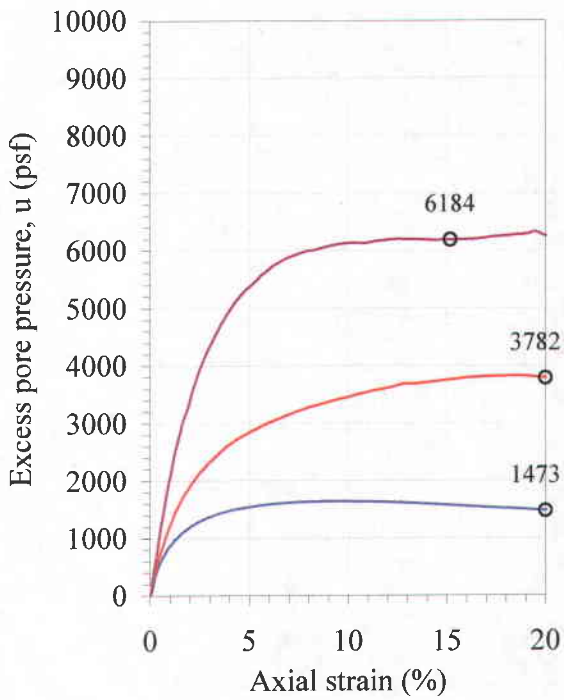
Project Number: M00991-001

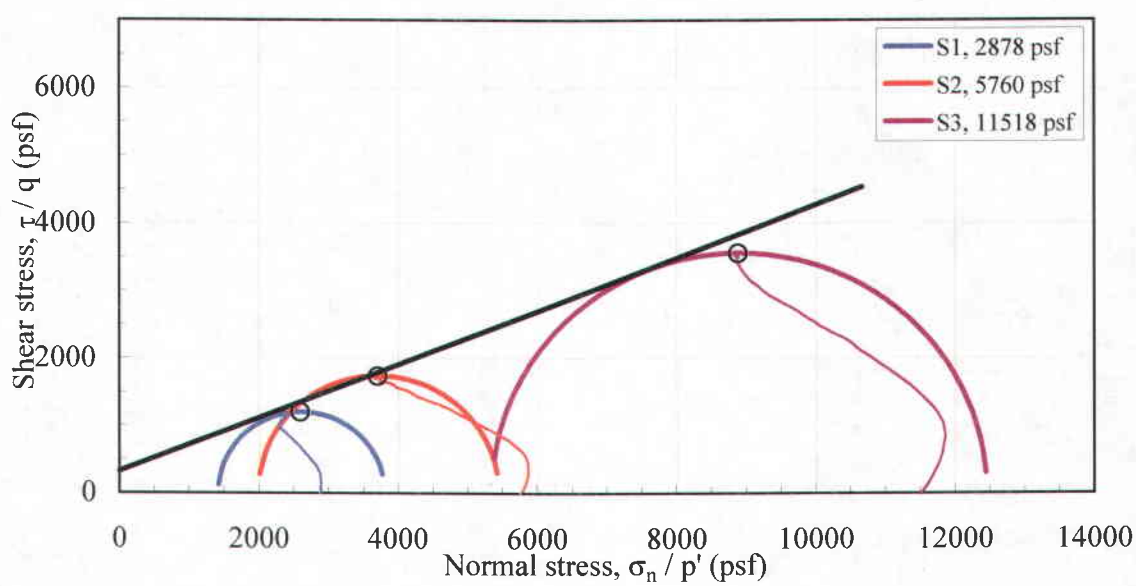
Sample: CH-1-3

Comments:

Summary of Strength Paramaters	Total Stress	Effective Stress
c (psf)	223	319
ϕ (deg)	12.6	21.6
tan ϕ	0.224	0.396







Project Name: Taylor Geo-Engineering
Project Number: M00991-001
Sample: CH-1-3
Comments: Samples were compacted to 90% of ASTM D698 at
Test Number: S1

Z:\PROJECTS\M00991_Taylor_Geo-Engineering\001\[GTXCU3v1_CH-1-3.xls]s1

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
0.00	-10	0	2878	2868	-5	2873	2873	1.004
0.02	125	56	2822	2947	62	2941	2885	1.044
0.04	133	67	2812	2945	67	2945	2878	1.047
0.06	138	73	2807	2945	69	2948	2876	1.049
0.08	151	78	2800	2950	75	2954	2875	1.054
0.10	259	122	2757	3016	130	3008	2886	1.094
0.20	572	294	2584	3156	286	3164	2870	1.221
0.30	731	409	2470	3201	366	3244	2835	1.296
0.40	843	498	2381	3223	421	3300	2802	1.354
0.50	937	584	2295	3232	468	3348	2764	1.408
0.60	1018	658	2220	3238	509	3387	2729	1.458
0.70	1086	718	2160	3246	543	3421	2703	1.502
0.80	1149	775	2103	3252	574	3453	2678	1.546
0.90	1203	829	2050	3254	602	3481	2652	1.587
1.00	1253	876	2002	3256	627	3505	2629	1.626
1.10	1299	919	1960	3259	650	3529	2610	1.663
1.20	1345	960	1918	3263	672	3551	2590	1.701
1.30	1382	994	1884	3266	691	3569	2575	1.733
1.40	1418	1031	1849	3267	709	3589	2558	1.767
1.50	1451	1062	1816	3267	725	3604	2542	1.799
1.60	1483	1093	1786	3269	742	3620	2527	1.831
1.70	1511	1122	1756	3268	756	3634	2512	1.860
1.80	1539	1148	1731	3270	770	3648	2500	1.889
1.90	1563	1172	1706	3269	782	3660	2488	1.916
2.00	1587	1197	1681	3268	793	3672	2475	1.944
2.10	1610	1218	1660	3271	805	3683	2465	1.970
2.20	1629	1239	1639	3269	815	3693	2454	1.994
2.30	1653	1259	1619	3272	826	3705	2446	2.021
2.40	1672	1279	1601	3273	836	3716	2437	2.045
2.50	1687	1297	1582	3269	843	3722	2425	2.066
2.60	1706	1313	1566	3271	853	3731	2418	2.090
2.70	1725	1329	1549	3274	862	3741	2412	2.113
2.80	1735	1345	1534	3269	868	3746	2402	2.131
2.90	1750	1359	1521	3271	875	3755	2396	2.151
3.00	1765	1373	1506	3271	882	3761	2388	2.172
3.10	1775	1386	1493	3268	888	3766	2380	2.189
3.20	1786	1397	1481	3267	893	3771	2374	2.206
3.30	1800	1409	1469	3270	900	3778	2370	2.225
3.40	1806	1421	1458	3264	903	3782	2361	2.239
3.50	1821	1431	1447	3268	910	3789	2358	2.258
3.60	1831	1442	1437	3268	916	3794	2352	2.275
3.70	1837	1451	1427	3264	919	3797	2346	2.287
3.80	1847	1461	1419	3267	924	3803	2343	2.302
3.90	1858	1469	1410	3267	929	3807	2339	2.318
4.00	1864	1478	1400	3264	932	3810	2332	2.331
4.10	1865	1485	1393	3259	933	3811	2326	2.339
4.20	1880	1494	1384	3264	940	3818	2324	2.358
4.30	1886	1502	1377	3263	943	3821	2320	2.370
4.40	1892	1507	1371	3263	946	3824	2317	2.380
4.50	1898	1514	1365	3263	949	3828	2314	2.390
4.60	1908	1521	1357	3265	954	3832	2311	2.406
4.70	1918	1527	1351	3269	959	3837	2310	2.419
4.80	1919	1533	1345	3265	960	3838	2305	2.427
4.90	1929	1539	1339	3269	965	3843	2304	2.441
5.00	1939	1545	1334	3273	970	3848	2303	2.454
5.10	1945	1550	1329	3274	973	3851	2302	2.464
5.20	1951	1555	1323	3274	976	3854	2299	2.475

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
5.30	1957	1559	1320	3276	978	3857	2298	2.483
5.40	1967	1565	1314	3280	983	3862	2297	2.497
5.50	1972	1569	1309	3281	986	3865	2295	2.507
5.60	1978	1573	1306	3284	989	3867	2295	2.515
5.70	1984	1576	1303	3287	992	3871	2295	2.522
5.80	1990	1580	1298	3288	995	3873	2293	2.532
5.90	1995	1583	1295	3290	998	3876	2293	2.541
6.00	2001	1587	1291	3292	1001	3879	2292	2.549
6.10	2011	1591	1288	3299	1005	3884	2293	2.561
6.20	2012	1593	1286	3298	1006	3884	2292	2.565
6.30	2022	1596	1282	3304	1011	3889	2293	2.577
6.40	2027	1599	1280	3307	1014	3892	2293	2.584
6.50	2037	1602	1276	3313	1019	3897	2295	2.596
6.60	2039	1605	1275	3314	1019	3899	2294	2.599
6.70	2048	1607	1272	3320	1024	3903	2296	2.611
6.80	2050	1609	1269	3319	1025	3903	2294	2.615
6.90	2055	1612	1267	3322	1028	3906	2294	2.622
7.00	2061	1614	1265	3325	1030	3909	2295	2.630
7.10	2062	1616	1262	3324	1031	3909	2293	2.634
7.20	2068	1617	1261	3329	1034	3912	2295	2.640
7.30	2073	1620	1259	3332	1037	3915	2295	2.647
7.40	2074	1621	1257	3332	1037	3916	2295	2.650
7.50	2080	1622	1256	3336	1040	3918	2296	2.656
7.60	2081	1623	1256	3337	1041	3920	2297	2.657
7.70	2087	1624	1254	3341	1043	3922	2297	2.664
7.80	2088	1626	1253	3341	1044	3922	2297	2.667
7.90	2093	1628	1250	3344	1047	3925	2297	2.674
8.00	2095	1628	1252	3346	1047	3927	2299	2.674
8.10	2100	1630	1248	3348	1050	3928	2298	2.683
8.20	2101	1630	1248	3349	1051	3929	2299	2.684
8.30	2107	1630	1248	3355	1053	3932	2301	2.688
8.40	2104	1632	1247	3351	1052	3930	2299	2.687
8.50	2117	1633	1247	3364	1059	3938	2305	2.698
8.60	2118	1634	1245	3363	1059	3938	2304	2.702
8.70	2120	1634	1245	3364	1060	3938	2304	2.703
8.80	2121	1634	1245	3366	1060	3939	2305	2.704
8.90	2130	1634	1245	3375	1065	3943	2310	2.711
9.00	2131	1635	1243	3375	1066	3944	2309	2.714
9.10	2133	1634	1245	3377	1066	3945	2311	2.713
9.20	2138	1634	1245	3382	1069	3947	2313	2.718
9.30	2143	1635	1243	3386	1071	3950	2315	2.723
9.40	2148	1636	1243	3391	1074	3954	2317	2.727
9.50	2157	1635	1243	3400	1079	3957	2322	2.735
9.60	2154	1635	1243	3398	1077	3956	2321	2.733
9.70	2163	1635	1243	3407	1082	3960	2325	2.740
9.80	2164	1634	1245	3409	1082	3961	2327	2.739
9.90	2169	1634	1245	3414	1085	3963	2329	2.743
10.00	2174	1634	1246	3420	1087	3967	2333	2.746
10.10	2179	1634	1246	3425	1090	3969	2336	2.750
10.20	2185	1634	1245	3429	1092	3971	2337	2.755
10.30	2190	1633	1246	3435	1095	3973	2341	2.758
10.40	2195	1633	1246	3440	1097	3976	2343	2.762
10.50	2196	1633	1246	3441	1098	3976	2344	2.762
10.60	2201	1633	1246	3446	1100	3979	2346	2.766
10.70	2205	1632	1248	3454	1103	3982	2351	2.767
10.80	2206	1632	1247	3453	1103	3982	2350	2.770
10.90	2208	1632	1247	3454	1104	3982	2351	2.770
11.00	2209	1630	1248	3457	1104	3983	2352	2.770
11.10	2209	1630	1249	3459	1105	3984	2354	2.769
11.20	2214	1629	1249	3464	1107	3986	2356	2.773
11.30	2215	1628	1250	3466	1108	3986	2358	2.772
11.40	2220	1627	1253	3473	1110	3990	2363	2.772
11.50	2221	1628	1252	3473	1111	3990	2362	2.775
11.60	2230	1627	1253	3483	1115	3995	2368	2.780

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
11.70	2231	1624	1254	3485	1115	3994	2369	2.779
11.80	2228	1623	1256	3484	1114	3994	2370	2.773
11.90	2233	1623	1255	3488	1116	3995	2371	2.779
12.00	2234	1622	1256	3490	1117	3995	2373	2.778
12.10	2238	1621	1257	3496	1119	3998	2377	2.780
12.20	2239	1620	1259	3498	1120	3998	2378	2.779
12.30	2244	1619	1260	3504	1122	4000	2382	2.781
12.40	2245	1617	1261	3506	1122	4001	2383	2.780
12.50	2249	1616	1262	3512	1125	4003	2387	2.782
12.60	2254	1615	1263	3517	1127	4006	2390	2.784
12.70	2259	1614	1266	3524	1129	4009	2395	2.785
12.80	2260	1613	1266	3525	1130	4008	2395	2.785
12.90	2264	1610	1268	3532	1132	4011	2400	2.786
13.00	2273	1609	1269	3542	1136	4015	2405	2.791
13.10	2273	1607	1272	3545	1137	4015	2408	2.788
13.20	2278	1606	1274	3552	1139	4019	2413	2.788
13.30	2282	1605	1274	3556	1141	4020	2415	2.792
13.40	2291	1603	1275	3566	1145	4024	2420	2.797
13.50	2295	1601	1277	3573	1148	4026	2425	2.797
13.60	2296	1600	1279	3575	1148	4026	2427	2.796
13.70	2301	1598	1281	3581	1150	4029	2431	2.796
13.80	2305	1595	1283	3588	1153	4031	2436	2.796
13.90	2306	1594	1284	3590	1153	4031	2437	2.795
14.00	2306	1592	1287	3593	1153	4032	2440	2.792
14.10	2311	1591	1288	3599	1155	4034	2443	2.794
14.20	2315	1588	1290	3606	1158	4036	2448	2.794
14.30	2316	1587	1293	3609	1158	4037	2451	2.792
14.40	2320	1585	1294	3614	1160	4039	2454	2.793
14.50	2321	1582	1296	3617	1161	4039	2457	2.791
14.60	2322	1581	1297	3619	1161	4039	2458	2.790
14.70	2322	1579	1300	3622	1161	4040	2461	2.787
14.80	2323	1576	1302	3625	1161	4040	2463	2.784
14.90	2331	1575	1303	3634	1165	4044	2469	2.789
15.00	2328	1573	1306	3633	1164	4042	2469	2.783
15.10	2328	1572	1307	3635	1164	4043	2471	2.782
15.20	2329	1569	1309	3638	1164	4043	2473	2.779
15.30	2329	1567	1311	3641	1165	4043	2476	2.776
15.40	2334	1566	1313	3646	1167	4045	2479	2.778
15.50	2334	1564	1315	3649	1167	4046	2482	2.775
15.60	2335	1561	1317	3652	1167	4046	2485	2.773
15.70	2335	1559	1320	3655	1168	4046	2487	2.770
15.80	2340	1558	1321	3660	1170	4048	2491	2.771
15.90	2340	1555	1323	3663	1170	4048	2493	2.769
16.00	2341	1553	1327	3667	1170	4050	2497	2.764
16.10	2345	1552	1327	3671	1172	4051	2499	2.768
16.20	2345	1550	1329	3674	1173	4051	2502	2.765
16.30	2349	1548	1330	3679	1175	4053	2505	2.766
16.40	2350	1546	1334	3683	1175	4055	2509	2.762
16.50	2354	1544	1334	3688	1177	4054	2511	2.765
16.60	2358	1542	1337	3695	1179	4059	2516	2.764
16.70	2358	1541	1338	3697	1179	4059	2518	2.762
16.80	2363	1538	1341	3703	1181	4060	2522	2.762
16.90	2367	1535	1343	3710	1183	4062	2526	2.762
17.00	2367	1534	1344	3711	1184	4062	2528	2.761
17.10	2371	1532	1347	3717	1186	4064	2532	2.761
17.20	2371	1530	1349	3720	1186	4064	2535	2.758
17.30	2375	1527	1351	3727	1188	4066	2539	2.758
17.40	2376	1526	1352	3728	1188	4066	2540	2.757
17.50	2376	1524	1355	3731	1188	4066	2543	2.754
17.60	2376	1521	1357	3733	1188	4067	2545	2.751
17.70	2377	1520	1358	3735	1188	4067	2547	2.750
17.80	2381	1518	1361	3741	1190	4069	2551	2.750
17.90	2381	1516	1363	3744	1191	4069	2553	2.747
18.00	2381	1514	1365	3747	1191	4070	2556	2.744

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
18.10	2382	1512	1366	3748	1191	4069	2557	2.743
18.20	2382	1510	1369	3751	1191	4069	2560	2.740
18.30	2382	1507	1371	3753	1191	4070	2562	2.738
18.40	2383	1506	1372	3755	1191	4070	2564	2.736
18.50	2383	1504	1375	3757	1191	4070	2566	2.733
18.60	2387	1502	1377	3764	1193	4072	2570	2.733
18.70	2383	1499	1379	3763	1192	4070	2571	2.728
18.80	2383	1498	1382	3765	1192	4071	2573	2.725
18.90	2384	1496	1383	3767	1192	4070	2575	2.724
19.00	2384	1493	1385	3769	1192	4070	2577	2.721
19.10	2384	1491	1387	3772	1192	4071	2580	2.718
19.20	2384	1490	1389	3773	1192	4071	2581	2.717
19.30	2385	1487	1391	3776	1192	4071	2583	2.714
19.40	2388	1486	1392	3781	1194	4073	2586	2.716
19.50	2389	1484	1395	3783	1194	4073	2589	2.713
19.60	2392	1482	1397	3789	1196	4075	2593	2.713
19.70	2389	1480	1398	3787	1195	4073	2593	2.709
19.80	2393	1478	1400	3793	1196	4075	2597	2.709
19.90	2393	1477	1402	3794	1196	4075	2598	2.707
20.00	2393	1473	1405	3798	1197	4075	2602	2.703

Project Name: Taylor Geo-Engineering
Project Number: M00991-001
Sample: CH-1-3
Comments: Samples were compacted to 90% of ASTM D698 at
Test Number: S2

Z:\PROJECTS\M00991_Taylor_Geo-Engineering\001\[GTXCU3v1_CH-1-3.xls]s2

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
0.00	-14	0	5760	5746	-7	5753	5753	1.002
0.02	225	59	5701	5927	113	5872	5814	1.040
0.04	391	112	5647	6038	195	5955	5842	1.069
0.06	508	158	5602	6109	254	6014	5855	1.091
0.08	599	200	5559	6158	300	6059	5859	1.108
0.10	677	240	5520	6197	339	6098	5858	1.123
0.20	937	379	5380	6317	468	6228	5848	1.174
0.30	1113	500	5260	6373	557	6316	5816	1.212
0.40	1254	625	5134	6389	627	6387	5761	1.244
0.50	1370	743	5017	6387	685	6444	5702	1.273
0.60	1467	856	4903	6371	734	6493	5637	1.299
0.70	1556	957	4803	6359	778	6538	5581	1.324
0.80	1636	1060	4699	6335	818	6577	5517	1.348
0.90	1707	1158	4602	6310	854	6615	5456	1.371
1.00	1779	1252	4508	6286	889	6649	5397	1.395
1.10	1841	1336	4423	6264	920	6680	5344	1.416
1.20	1895	1417	4342	6237	947	6707	5290	1.436
1.30	1944	1492	4268	6211	972	6731	5239	1.455
1.40	1993	1562	4198	6191	996	6757	5195	1.475
1.50	2042	1630	4129	6171	1021	6781	5150	1.494
1.60	2086	1696	4064	6150	1043	6803	5107	1.513
1.70	2122	1754	4006	6129	1061	6822	5068	1.530
1.80	2158	1808	3951	6110	1079	6839	5030	1.546
1.90	2198	1860	3901	6099	1099	6860	5000	1.564
2.00	2234	1910	3849	6083	1117	6877	4966	1.580
2.10	2270	1959	3800	6070	1135	6894	4935	1.597
2.20	2297	2007	3752	6049	1148	6908	4901	1.612
2.30	2328	2054	3705	6033	1164	6924	4869	1.628
2.40	2363	2100	3661	6024	1182	6942	4843	1.646
2.50	2390	2142	3619	6009	1195	6956	4814	1.661
2.60	2421	2183	3577	5998	1211	6970	4787	1.677
2.70	2448	2221	3539	5987	1224	6984	4763	1.692
2.80	2475	2256	3504	5979	1237	6997	4741	1.706
2.90	2493	2289	3471	5964	1246	7006	4718	1.718
3.00	2519	2325	3435	5954	1260	7019	4695	1.733
3.10	2546	2359	3401	5947	1273	7033	4674	1.749
3.20	2564	2389	3370	5934	1282	7042	4652	1.761
3.30	2582	2423	3338	5919	1291	7052	4629	1.774
3.40	2604	2456	3304	5908	1302	7062	4606	1.788
3.50	2622	2489	3271	5893	1311	7071	4582	1.802
3.60	2640	2522	3239	5879	1320	7081	4559	1.815
3.70	2653	2551	3209	5862	1327	7086	4535	1.827
3.80	2667	2588	3171	5838	1333	7093	4505	1.841
3.90	2685	2612	3149	5834	1342	7103	4491	1.853
4.00	2694	2633	3127	5821	1347	7107	4474	1.862
4.10	2707	2657	3102	5810	1354	7113	4456	1.873
4.20	2717	2680	3080	5797	1358	7118	4438	1.882
4.30	2730	2702	3058	5788	1365	7125	4423	1.893
4.40	2739	2725	3034	5774	1370	7129	4404	1.903
4.50	2757	2745	3014	5771	1378	7138	4393	1.915
4.60	2770	2768	2992	5762	1385	7145	4377	1.926
4.70	2779	2786	2973	5753	1390	7149	4363	1.935
4.80	2788	2799	2960	5749	1394	7154	4355	1.942
4.90	2802	2819	2941	5742	1401	7160	4341	1.953
5.00	2806	2840	2920	5726	1403	7163	4323	1.961
5.10	2820	2858	2902	5722	1410	7169	4312	1.972
5.20	2829	2876	2884	5713	1414	7175	4299	1.981

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
5.30	2842	2894	2866	5707	1421	7180	4286	1.992
5.40	2846	2912	2849	5696	1423	7184	4272	1.999
5.50	2860	2930	2831	5690	1430	7191	4260	2.010
5.60	2873	2947	2813	5686	1436	7196	4249	2.021
5.70	2886	2963	2797	5682	1443	7202	4239	2.032
5.80	2898	2978	2781	5680	1449	7209	4231	2.042
5.90	2911	2995	2765	5676	1456	7215	4221	2.053
6.00	2924	3011	2749	5673	1462	7222	4211	2.064
6.10	2933	3026	2732	5665	1467	7225	4199	2.074
6.20	2946	3043	2718	5664	1473	7234	4191	2.084
6.30	2959	3054	2705	5664	1479	7239	4184	2.094
6.40	2971	3069	2691	5662	1486	7245	4177	2.104
6.50	2980	3080	2679	5659	1490	7250	4169	2.112
6.60	2988	3094	2667	5655	1494	7255	4161	2.121
6.70	3001	3108	2651	5652	1501	7260	4152	2.132
6.80	3010	3122	2638	5648	1505	7266	4143	2.141
6.90	3018	3135	2624	5643	1509	7269	4133	2.150
7.00	3027	3148	2611	5638	1513	7273	4125	2.159
7.10	3035	3162	2597	5633	1518	7277	4115	2.169
7.20	3044	3175	2585	5628	1522	7281	4106	2.178
7.30	3048	3188	2572	5620	1524	7284	4096	2.185
7.40	3052	3201	2560	5612	1526	7287	4086	2.192
7.50	3061	3213	2547	5608	1530	7290	4077	2.202
7.60	3065	3223	2537	5602	1533	7292	4069	2.208
7.70	3069	3235	2525	5594	1535	7294	4060	2.216
7.80	3074	3247	2513	5587	1537	7296	4050	2.223
7.90	3074	3257	2503	5577	1537	7297	4040	2.228
8.00	3082	3270	2490	5572	1541	7301	4031	2.238
8.10	3091	3281	2479	5570	1545	7305	4024	2.247
8.20	3091	3290	2471	5562	1545	7306	4016	2.251
8.30	3099	3300	2459	5558	1550	7309	4009	2.260
8.40	3103	3311	2450	5553	1552	7312	4001	2.267
8.50	3107	3320	2439	5547	1554	7313	3993	2.274
8.60	3111	3330	2431	5543	1556	7317	3987	2.280
8.70	3112	3339	2422	5533	1556	7317	3978	2.285
8.80	3120	3348	2411	5531	1560	7319	3971	2.294
8.90	3128	3358	2403	5531	1564	7325	3967	2.302
9.00	3132	3366	2394	5526	1566	7326	3960	2.308
9.10	3140	3377	2383	5523	1570	7330	3953	2.318
9.20	3148	3386	2374	5522	1574	7334	3948	2.326
9.30	3156	3394	2366	5522	1578	7338	3944	2.334
9.40	3168	3402	2357	5525	1584	7344	3941	2.344
9.50	3176	3412	2348	5524	1588	7347	3936	2.353
9.60	3188	3421	2339	5526	1594	7353	3932	2.363
9.70	3196	3429	2330	5526	1598	7357	3928	2.371
9.80	3199	3437	2323	5523	1600	7360	3923	2.377
9.90	3207	3446	2314	5521	1604	7363	3918	2.386
10.00	3215	3453	2308	5523	1608	7368	3916	2.393
10.10	3219	3463	2296	5515	1610	7369	3906	2.402
10.20	3231	3473	2287	5518	1615	7375	3902	2.413
10.30	3234	3483	2277	5511	1617	7377	3894	2.421
10.40	3238	3490	2270	5508	1619	7379	3889	2.427
10.50	3242	3500	2260	5502	1621	7381	3881	2.434
10.60	3246	3507	2253	5499	1623	7382	3876	2.441
10.70	3250	3516	2244	5493	1625	7384	3868	2.448
10.80	3253	3524	2237	5490	1627	7387	3863	2.454
10.90	3253	3532	2227	5480	1627	7386	3854	2.461
11.00	3257	3539	2220	5477	1628	7388	3849	2.467
11.10	3260	3548	2212	5473	1630	7390	3842	2.474
11.20	3260	3556	2205	5465	1630	7391	3835	2.479
11.30	3264	3564	2196	5460	1632	7392	3828	2.487
11.40	3268	3571	2189	5456	1634	7393	3822	2.493
11.50	3267	3579	2180	5448	1634	7393	3814	2.499
11.60	3271	3586	2175	5446	1636	7396	3810	2.504

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
11.70	3275	3593	2166	5441	1637	7397	3804	2.512
11.80	3274	3600	2159	5434	1637	7397	3797	2.516
11.90	3278	3607	2152	5430	1639	7399	3791	2.523
12.00	3278	3614	2145	5423	1639	7399	3784	2.528
12.10	3274	3621	2138	5412	1637	7396	3775	2.531
12.20	3277	3627	2132	5410	1639	7398	3771	2.537
12.30	3277	3634	2127	5403	1638	7399	3765	2.541
12.40	3284	3647	2114	5398	1642	7403	3756	2.554
12.50	3284	3659	2101	5385	1642	7402	3743	2.563
12.60	3291	3665	2095	5386	1646	7405	3741	2.571
12.70	3295	3671	2089	5384	1647	7407	3736	2.577
12.80	3302	3676	2083	5385	1651	7410	3734	2.585
12.90	3305	3679	2081	5386	1653	7412	3734	2.588
13.00	3312	3679	2082	5394	1656	7417	3738	2.591
13.10	3320	3676	2083	5403	1660	7419	3743	2.593
13.20	3323	3676	2084	5407	1661	7422	3746	2.594
13.30	3330	3676	2084	5414	1665	7426	3749	2.598
13.40	3341	3680	2080	5421	1670	7430	3750	2.606
13.50	3344	3686	2074	5418	1672	7432	3746	2.613
13.60	3347	3688	2072	5419	1674	7433	3745	2.616
13.70	3351	3693	2067	5418	1675	7435	3742	2.621
13.80	3358	3696	2065	5422	1679	7440	3743	2.626
13.90	3361	3701	2059	5420	1681	7440	3739	2.633
14.00	3364	3704	2055	5419	1682	7442	3737	2.637
14.10	3364	3709	2052	5415	1682	7443	3733	2.639
14.20	3367	3714	2047	5414	1683	7444	3730	2.645
14.30	3374	3719	2041	5415	1687	7446	3728	2.653
14.40	3373	3723	2036	5410	1687	7446	3723	2.656
14.50	3376	3728	2032	5408	1688	7448	3720	2.662
14.60	3376	3731	2029	5405	1688	7449	3717	2.663
14.70	3379	3735	2025	5403	1689	7449	3714	2.669
14.80	3378	3738	2021	5399	1689	7449	3710	2.671
14.90	3377	3743	2018	5395	1689	7450	3706	2.674
15.00	3377	3747	2013	5390	1688	7448	3701	2.678
15.10	3380	3749	2011	5391	1690	7450	3701	2.681
15.20	3376	3753	2007	5383	1688	7447	3695	2.682
15.30	3379	3755	2005	5383	1689	7449	3694	2.685
15.40	3374	3760	2000	5374	1687	7447	3687	2.687
15.50	3374	3764	1997	5370	1687	7448	3683	2.690
15.60	3373	3768	1993	5366	1686	7447	3680	2.692
15.70	3372	3772	1988	5361	1686	7447	3674	2.696
15.80	3368	3776	1984	5352	1684	7444	3668	2.698
15.90	3367	3779	1981	5348	1684	7444	3665	2.699
16.00	3374	3783	1978	5352	1687	7448	3665	2.706
16.10	3377	3785	1974	5351	1688	7448	3663	2.710
16.20	3380	3786	1974	5354	1690	7451	3664	2.712
16.30	3382	3790	1971	5353	1691	7452	3662	2.716
16.40	3385	3791	1969	5354	1693	7452	3661	2.720
16.50	3392	3794	1966	5358	1696	7456	3662	2.725
16.60	3395	3796	1964	5358	1697	7457	3661	2.729
16.70	3397	3797	1963	5360	1699	7458	3661	2.731
16.80	3404	3799	1960	5364	1702	7462	3662	2.736
16.90	3407	3801	1959	5366	1703	7463	3662	2.739
17.00	3413	3802	1958	5371	1707	7466	3664	2.743
17.10	3419	3802	1959	5378	1710	7471	3669	2.745
17.20	3426	3804	1956	5381	1713	7472	3668	2.752
17.30	3428	3806	1954	5383	1714	7475	3669	2.754
17.40	3435	3806	1953	5388	1717	7477	3671	2.758
17.50	3437	3806	1953	5391	1719	7478	3672	2.760
17.60	3436	3806	1953	5390	1718	7478	3672	2.759
17.70	3439	3808	1952	5391	1720	7479	3672	2.762
17.80	3442	3808	1952	5394	1721	7480	3673	2.763
17.90	3444	3809	1951	5395	1722	7482	3673	2.765
18.00	3443	3810	1950	5393	1722	7481	3671	2.766

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
18.10	3446	3812	1949	5394	1723	7484	3672	2.768
18.20	3441	3810	1950	5391	1721	7480	3670	2.765
18.30	3440	3811	1949	5389	1720	7480	3669	2.766
18.40	3439	3812	1947	5387	1720	7479	3667	2.766
18.50	3438	3812	1947	5386	1719	7479	3667	2.766
18.60	3441	3813	1946	5387	1720	7480	3667	2.768
18.70	3436	3811	1950	5386	1718	7479	3668	2.762
18.80	3435	3810	1950	5385	1718	7477	3667	2.762
18.90	3431	3808	1952	5383	1715	7475	3667	2.757
19.00	3433	3808	1952	5385	1717	7476	3669	2.759
19.10	3432	3805	1954	5386	1716	7476	3670	2.756
19.20	3434	3804	1956	5390	1717	7477	3673	2.756
19.30	3430	3799	1961	5391	1715	7476	3676	2.749
19.40	3436	3797	1963	5398	1718	7478	3681	2.751
19.50	3442	3795	1966	5408	1721	7482	3687	2.750
19.60	3444	3791	1969	5413	1722	7482	3691	2.750
19.70	3446	3788	1972	5418	1723	7483	3695	2.748
19.80	3449	3785	1974	5423	1724	7484	3699	2.747
19.90	3455	3785	1974	5429	1727	7487	3702	2.750
20.00	3460	3782	1978	5438	1730	7490	3708	2.750

Project Name: Taylor Geo-Engineering
Project Number: M00991-001
Sample: CH-1-3
Comments: Samples were compacted to 90% of ASTM D698 at
Test Number: S3

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Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
0.00	-29	0	11518	11488	-15	11503	11503	1.003
0.02	344	61	11457	11801	172	11690	11629	1.030
0.04	614	124	11393	12008	307	11825	11701	1.054
0.06	824	180	11337	12161	412	11929	11749	1.073
0.08	1011	238	11280	12290	505	12023	11785	1.090
0.10	1155	286	11232	12387	577	12095	11809	1.103
0.20	1689	511	11008	12697	845	12364	11853	1.153
0.30	2055	718	10801	12855	1027	12546	11828	1.190
0.40	2350	946	10572	12922	1175	12693	11747	1.222
0.50	2593	1160	10358	12951	1297	12815	11655	1.250
0.60	2808	1369	10149	12957	1404	12922	11553	1.277
0.70	2995	1564	9954	12949	1498	13016	11452	1.301
0.80	3182	1757	9761	12942	1591	13109	11352	1.326
0.90	3344	1940	9578	12923	1672	13190	11250	1.349
1.00	3493	2114	9404	12897	1747	13264	11150	1.371
1.10	3632	2283	9235	12867	1816	13334	11051	1.393
1.20	3762	2441	9078	12840	1881	13400	10959	1.414
1.30	3882	2586	8932	12814	1941	13459	10873	1.435
1.40	4002	2727	8791	12793	2001	13519	10792	1.455
1.50	4108	2860	8658	12766	2054	13572	10712	1.474
1.60	4209	2984	8532	12741	2105	13621	10637	1.493
1.70	4305	3103	8415	12720	2153	13671	10568	1.512
1.80	4401	3184	8333	12734	2201	13718	10534	1.528
1.90	4492	3292	8227	12719	2246	13765	10473	1.546
2.00	4574	3406	8113	12687	2287	13806	10400	1.564
2.10	4661	3536	7982	12643	2330	13848	10312	1.584
2.20	4738	3653	7865	12602	2369	13887	10234	1.602
2.30	4815	3760	7758	12573	2407	13925	10165	1.621
2.40	4891	3858	7660	12551	2446	13963	10105	1.639
2.50	4959	3952	7566	12525	2479	13997	10045	1.655
2.60	5026	4039	7478	12504	2513	14031	9991	1.672
2.70	5097	4123	7396	12494	2549	14068	9945	1.689
2.80	5160	4205	7313	12473	2580	14098	9893	1.706
2.90	5222	4280	7238	12460	2611	14129	9849	1.721
3.00	5275	4350	7168	12443	2638	14155	9806	1.736
3.10	5328	4413	7105	12433	2664	14182	9769	1.750
3.20	5386	4473	7044	12429	2693	14209	9737	1.765
3.30	5438	4545	6972	12410	2719	14237	9691	1.780
3.40	5486	4612	6906	12392	2743	14261	9649	1.794
3.50	5530	4675	6843	12373	2765	14284	9608	1.808
3.60	5578	4739	6779	12357	2789	14306	9568	1.823
3.70	5616	4798	6721	12337	2808	14327	9529	1.836
3.80	5659	4857	6661	12320	2830	14347	9490	1.850
3.90	5698	4912	6606	12304	2849	14367	9455	1.863
4.00	5736	4964	6554	12291	2868	14386	9422	1.875
4.10	5775	5015	6503	12277	2887	14405	9390	1.888
4.20	5818	5065	6452	12270	2909	14426	9361	1.902
4.30	5851	5112	6405	12257	2926	14443	9331	1.913
4.40	5885	5156	6362	12247	2943	14460	9305	1.925
4.50	5918	5198	6320	12238	2959	14477	9279	1.936
4.60	5956	5238	6280	12236	2978	14496	9258	1.948
4.70	5985	5275	6243	12228	2993	14510	9235	1.959
4.80	6023	5308	6210	12233	3012	14529	9221	1.970
4.90	6052	5341	6177	12229	3026	14544	9203	1.980
5.00	6085	5371	6147	12232	3043	14560	9189	1.990
5.10	6109	5400	6117	12226	3055	14572	9172	1.999
5.20	6138	5426	6092	12229	3069	14587	9160	2.008

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
5.30	6166	5464	6054	12220	3083	14601	9137	2.019
5.40	6199	5498	6021	12220	3100	14618	9121	2.030
5.50	6227	5533	5984	12211	3114	14630	9097	2.041
5.60	6256	5569	5949	12204	3128	14645	9076	2.052
5.70	6284	5598	5919	12203	3142	14659	9061	2.062
5.80	6312	5626	5891	12203	3156	14674	9047	2.071
5.90	6340	5653	5864	12204	3170	14688	9034	2.081
6.00	6372	5680	5837	12210	3186	14704	9024	2.092
6.10	6400	5706	5812	12212	3200	14718	9012	2.101
6.20	6419	5732	5786	12205	3210	14727	8995	2.109
6.30	6447	5752	5766	12213	3223	14741	8989	2.118
6.40	6474	5774	5744	12218	3237	14755	8981	2.127
6.50	6498	5795	5723	12220	3249	14767	8972	2.135
6.60	6521	5816	5702	12222	3260	14778	8962	2.144
6.70	6544	5835	5683	12227	3272	14790	8955	2.152
6.80	6567	5850	5668	12235	3284	14801	8951	2.159
6.90	6586	5866	5651	12237	3293	14810	8944	2.165
7.00	6600	5881	5637	12237	3300	14818	8937	2.171
7.10	6614	5895	5624	12238	3307	14826	8931	2.176
7.20	6632	5907	5610	12243	3316	14834	8926	2.182
7.30	6651	5920	5597	12248	3325	14843	8923	2.188
7.40	6665	5932	5586	12250	3332	14850	8918	2.193
7.50	6679	5944	5575	12254	3339	14858	8914	2.198
7.60	6693	5959	5560	12253	3346	14865	8906	2.204
7.70	6707	5968	5549	12256	3353	14871	8903	2.209
7.80	6721	5978	5540	12260	3360	14878	8900	2.213
7.90	6734	5987	5531	12265	3367	14885	8898	2.218
8.00	6748	5998	5520	12268	3374	14892	8894	2.222
8.10	6757	5996	5521	12279	3379	14896	8900	2.224
8.20	6763	5999	5519	12281	3381	14899	8900	2.225
8.30	6772	6002	5515	12287	3386	14904	8901	2.228
8.40	6785	6016	5502	12288	3393	14912	8895	2.233
8.50	6795	6027	5491	12285	3397	14915	8888	2.238
8.60	6804	6039	5479	12283	3402	14920	8881	2.242
8.70	6813	6049	5470	12283	3407	14925	8876	2.246
8.80	6827	6059	5459	12286	3413	14931	8872	2.250
8.90	6831	6068	5450	12281	3416	14933	8865	2.254
9.00	6845	6077	5440	12285	3422	14940	8863	2.258
9.10	6850	6083	5435	12284	3425	14942	8859	2.260
9.20	6854	6090	5428	12282	3427	14945	8855	2.263
9.30	6872	6096	5423	12295	3436	14955	8859	2.267
9.40	6881	6101	5417	12298	3440	14958	8857	2.270
9.50	6890	6108	5411	12301	3445	14964	8856	2.273
9.60	6899	6114	5404	12303	3449	14967	8853	2.277
9.70	6907	6118	5401	12308	3454	14972	8854	2.279
9.80	6912	6122	5396	12308	3456	14974	8852	2.281
9.90	6925	6122	5397	12322	3462	14981	8860	2.283
10.00	6934	6126	5392	12326	3467	14986	8859	2.286
10.10	6947	6129	5389	12335	3473	14991	8862	2.289
10.20	6951	6129	5389	12340	3476	14993	8864	2.290
10.30	6955	6129	5389	12344	3478	14995	8867	2.291
10.40	6968	6131	5387	12355	3484	15002	8871	2.294
10.50	6973	6132	5385	12358	3486	15004	8872	2.295
10.60	6977	6126	5391	12368	3488	15006	8880	2.294
10.70	6985	6125	5392	12378	3493	15010	8885	2.295
10.80	6985	6122	5396	12381	3493	15010	8889	2.295
10.90	6994	6130	5389	12383	3497	15016	8886	2.298
11.00	6998	6136	5383	12381	3499	15018	8882	2.300
11.10	7002	6142	5377	12379	3501	15020	8878	2.302
11.20	7006	6146	5371	12378	3503	15021	8874	2.304
11.30	7011	6155	5363	12374	3505	15023	8868	2.307
11.40	7015	6160	5357	12372	3507	15025	8865	2.309
11.50	7010	6164	5354	12364	3505	15023	8859	2.309
11.60	7015	6171	5347	12361	3507	15025	8854	2.312

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
11.70	7019	6176	5342	12361	3509	15027	8851	2.314
11.80	7023	6178	5341	12363	3511	15030	8852	2.315
11.90	7027	6183	5335	12362	3513	15031	8848	2.317
12.00	7031	6186	5331	12362	3515	15033	8847	2.319
12.10	7030	6189	5330	12361	3515	15034	8845	2.319
12.20	7030	6191	5327	12357	3515	15033	8842	2.320
12.30	7038	6193	5324	12363	3519	15037	8844	2.322
12.40	7034	6197	5321	12355	3517	15035	8838	2.322
12.50	7038	6197	5322	12360	3519	15038	8841	2.322
12.60	7046	6197	5321	12366	3523	15040	8844	2.324
12.70	7045	6197	5321	12366	3523	15040	8844	2.324
12.80	7045	6196	5322	12367	3522	15040	8845	2.324
12.90	7045	6196	5322	12367	3522	15040	8844	2.324
13.00	7048	6196	5322	12370	3524	15042	8846	2.324
13.10	7048	6194	5323	12371	3524	15042	8847	2.324
13.20	7056	6196	5323	12379	3528	15047	8851	2.325
13.30	7059	6193	5324	12384	3530	15047	8854	2.326
13.40	7059	6193	5324	12383	3529	15047	8854	2.326
13.50	7062	6191	5327	12389	3531	15049	8858	2.326
13.60	7070	6190	5328	12398	3535	15053	8863	2.327
13.70	7073	6189	5330	12404	3537	15055	8867	2.327
13.80	7073	6189	5329	12402	3537	15054	8866	2.327
13.90	7080	6187	5330	12411	3540	15058	8871	2.328
14.00	7088	6184	5334	12422	3544	15062	8878	2.329
14.10	7091	6184	5334	12425	3546	15063	8879	2.330
14.20	7091	6183	5336	12427	3545	15064	8881	2.329
14.30	7094	6184	5334	12428	3547	15065	8881	2.330
14.40	7093	6178	5340	12433	3547	15064	8886	2.328
14.50	7101	6179	5339	12439	3550	15068	8889	2.330
14.60	7100	6180	5337	12437	3550	15068	8887	2.330
14.70	7107	6180	5337	12444	3554	15071	8891	2.332
14.80	7106	6183	5335	12441	3553	15071	8888	2.332
14.90	7106	6182	5336	12442	3553	15070	8889	2.332
15.00	7105	6182	5336	12441	3552	15070	8889	2.331
15.10	7104	6182	5336	12440	3552	15070	8888	2.331
15.20	7111	6184	5334	12445	3556	15073	8889	2.333
15.30	7102	6185	5333	12435	3551	15069	8884	2.332
15.40	7094	6183	5335	12429	3547	15064	8882	2.330
15.50	7101	6185	5333	12433	3550	15068	8883	2.332
15.60	7100	6187	5331	12431	3550	15069	8881	2.332
15.70	7103	6189	5329	12432	3551	15069	8880	2.333
15.80	7106	6189	5329	12435	3553	15070	8882	2.333
15.90	7101	6190	5328	12429	3550	15068	8878	2.333
16.00	7100	6192	5326	12425	3550	15068	8876	2.333
16.10	7103	6191	5327	12429	3551	15069	8878	2.333
16.20	7098	6193	5324	12422	3549	15067	8873	2.333
16.30	7097	6196	5322	12419	3548	15066	8871	2.333
16.40	7100	6198	5320	12419	3550	15067	8870	2.335
16.50	7095	6200	5317	12412	3547	15065	8865	2.334
16.60	7094	6204	5314	12407	3547	15064	8861	2.335
16.70	7092	6208	5310	12403	3546	15065	8857	2.336
16.80	7091	6211	5307	12398	3546	15063	8853	2.336
16.90	7086	6216	5302	12389	3543	15061	8845	2.337
17.00	7089	6219	5300	12389	3545	15063	8844	2.338
17.10	7092	6224	5294	12386	3546	15064	8840	2.340
17.20	7091	6230	5288	12379	3545	15063	8833	2.341
17.30	7086	6231	5287	12372	3543	15060	8830	2.340
17.40	7088	6234	5283	12372	3544	15062	8828	2.342
17.50	7087	6238	5281	12368	3543	15062	8825	2.342
17.60	7089	6241	5276	12366	3545	15062	8821	2.344
17.70	7092	6246	5272	12364	3546	15064	8818	2.345
17.80	7087	6247	5271	12357	3543	15061	8814	2.345
17.90	7093	6251	5267	12360	3547	15064	8814	2.347
18.00	7096	6252	5267	12363	3548	15067	8815	2.347

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
18.10	7094	6252	5266	12360	3547	15065	8813	2.347
18.20	7097	6258	5260	12357	3548	15066	8808	2.349
18.30	7095	6261	5257	12352	3548	15065	8804	2.350
18.40	7094	6264	5254	12348	3547	15065	8801	2.350
18.50	7096	6268	5250	12346	3548	15066	8798	2.352
18.60	7091	6266	5252	12343	3546	15063	8797	2.350
18.70	7090	6271	5247	12337	3545	15062	8792	2.351
18.80	7092	6273	5245	12337	3546	15064	8791	2.352
18.90	7094	6276	5242	12336	3547	15066	8789	2.353
19.00	7089	6280	5238	12326	3544	15062	8782	2.353
19.10	7087	6285	5233	12320	3544	15061	8777	2.354
19.20	7082	6287	5232	12314	3541	15060	8773	2.354
19.30	7080	6317	5201	12282	3540	15059	8742	2.361
19.40	7082	6327	5191	12273	3541	15059	8732	2.364
19.50	7081	6322	5197	12277	3540	15059	8737	2.363
19.60	7075	6309	5210	12285	3538	15056	8747	2.358
19.70	7074	6289	5228	12302	3537	15054	8765	2.353
19.80	7064	6272	5247	12312	3532	15051	8779	2.346
19.90	7063	6258	5261	12324	3531	15050	8793	2.342
20.00	7065	6249	5269	12334	3532	15051	8802	2.341

Isotropically Consolidated Undrained with Pore Pressure (CIU/PP)

IGES

Project Name: **Taylor Geo-Engineering**
Project Number: **M00991-001**
Sample: **CH-5-48**
Comments: Samples were compacted to 90% of ASTM D698 at OMC.

Test Number		S1	S2	S3	
Initial	Height, H (in)	4.21	4.10	4.08	
	Diameter, D (in)	1.93	1.93	1.93	
	Moisture Content, w (%)	19.8	19.8	19.8	
	Dry Unit Weight, γd (pcf)	90.1	89.9	90.1	
	Saturation (%)	66.1	67.1	69.2	
	Void Ratio, e	0.81	0.84	0.81	
Before Shear	Moisture Content, w (%)	27.0	26.5	23.8	
	Dry Unit Weight, γd (pcf)	96.4	97.1	101.4	
	Saturation (%)	100.0	100.0	100.0	
	Void Ratio, e	0.73	0.72	0.64	
	B	0.95	0.95	0.95	
	Back pressure (psf)	17430	4434.1	4751.5	
	Strain rate (%/min)	0.033	0.033	0.033	
	Time to Failure (min)	590.9	509.1	584.8	
Total Stress	Strain at Failure, εf (%)	19.50	16.80	19.30	
	σ3 (psf)	2879	5763	11524	
	σ1-σ3 (psf)	2392	4023	7276	
	σ1 (psf)	5271	9786	18799	
	q = (σ1-σ3)/2 (psf)	1196	2012	3638	
	p = (σ1+σ3)/2 (psf)	4075	7775	15161	
Effective Stress	u (psf)	1332	3013	5413	
	σ'3 (psf)	1547	2750	6110	
	σ'1-σ'3 (psf)	2392	4023	7276	
	σ'1 (psf)	3939	6773	13386	
	q = (σ'1-σ'3)/2 (psf)	1196	2012	3638	
	p' = (σ'1+σ'3)/2 (psf)	2743	4761	9748	
	σ'1/σ'3	2.55	2.46	2.19	
	A = u/(σ1−σ3)	0.557	0.749	0.744	

Estimated Specific Gravity	2.70
Plastic Limit (%)	23
Liquid Limit (%)	61
Plasticity Index (%)	38

Summary of Strength Paramaters	Total Stress	Effective Stress
c (psf)	306	321
ϕ (deg)	12.7	20.1
tan ϕ	0.226	0.367

[a] Saturation set to 100% for phase calculations

Tested by:____________

Reviewed:____________

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Isotropically Consolidated Undrained with Pore Pressure (CIU/PP)

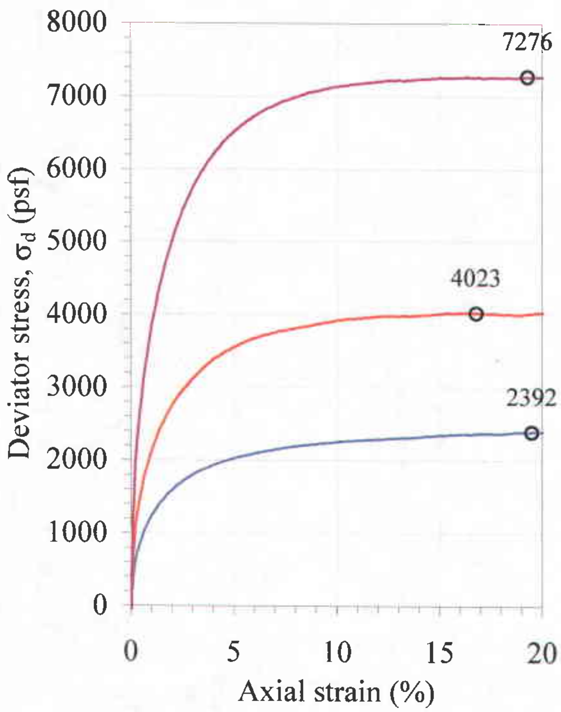
Project Name: Taylor Geo-Engineering

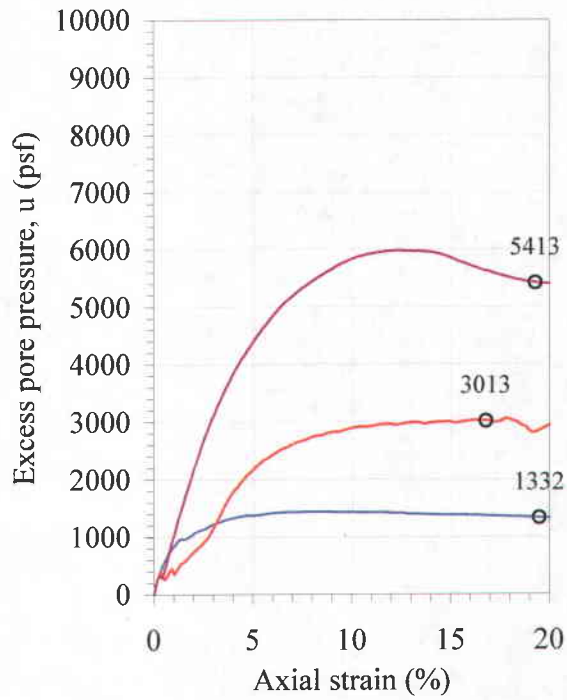
Project Number: M00991-001

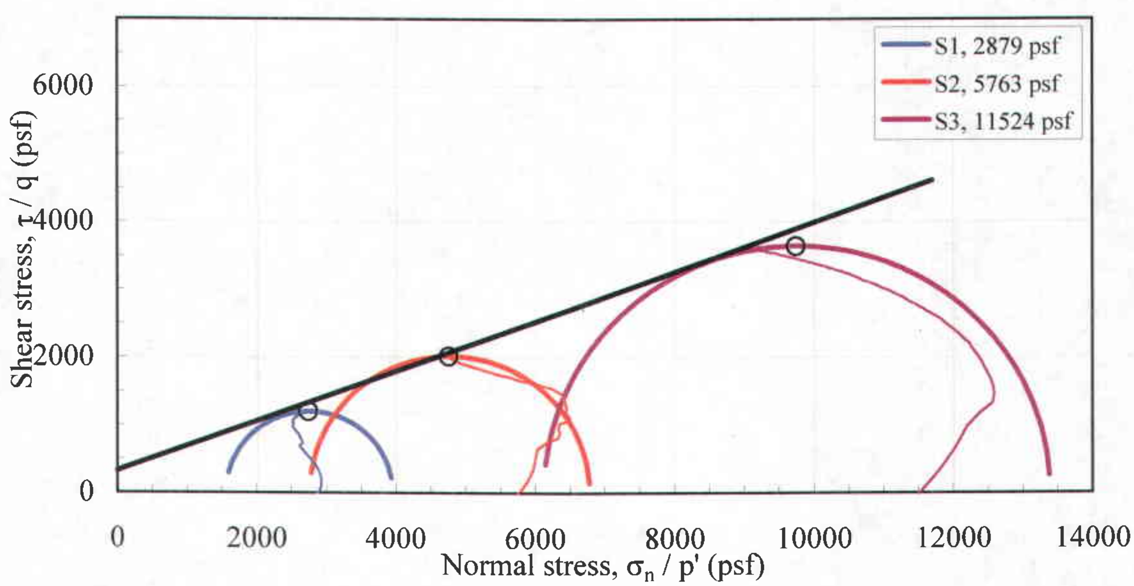
Sample: CH-5-48

Comments:

Summary of Strength Paramaters	Total Stress	Effective Stress
c (psf)	306	321
ϕ (deg)	12.7	20.1
tan ϕ	0.226	0.367







Project Name: Taylor Geo-Engineering
Project Number: M00991-001
Sample: CH-5-48
Comments: Samples were compacted to 90% of ASTM D698 at
Test Number: S1

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Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
0.00	-4	0	2879	2875	-2	2877	2877	1.001
0.02	190	56	2823	3013	95	2974	2918	1.067
0.04	267	98	2782	3049	134	3014	2916	1.096
0.06	339	134	2746	3084	169	3048	2915	1.123
0.08	397	165	2714	3111	198	3077	2912	1.146
0.10	448	193	2686	3134	224	3103	2910	1.167
0.20	628	307	2572	3200	314	3193	2886	1.244
0.30	749	399	2480	3229	375	3254	2854	1.302
0.40	851	483	2397	3248	426	3305	2822	1.355
0.50	933	560	2319	3253	467	3346	2786	1.403
0.60	1016	629	2250	3266	508	3387	2758	1.451
0.70	1085	698	2181	3266	542	3421	2723	1.497
0.80	1141	751	2130	3270	570	3451	2700	1.536
0.90	1197	799	2081	3278	598	3479	2680	1.575
1.00	1246	843	2037	3283	623	3503	2660	1.612
1.10	1289	885	1995	3284	645	3525	2639	1.646
1.20	1332	922	1959	3291	666	3546	2625	1.680
1.30	1375	957	1922	3298	688	3567	2610	1.716
1.40	1412	963	1916	3328	706	3585	2622	1.737
1.50	1448	956	1923	3371	724	3603	2647	1.753
1.60	1478	969	1910	3388	739	3618	2649	1.774
1.70	1514	990	1889	3403	757	3636	2646	1.801
1.80	1544	1013	1866	3410	772	3651	2638	1.827
1.90	1573	1035	1844	3417	787	3666	2630	1.853
2.00	1597	1055	1824	3420	798	3677	2622	1.875
2.10	1626	1078	1803	3429	813	3693	2616	1.902
2.20	1649	1097	1783	3432	825	3705	2607	1.925
2.30	1672	1114	1766	3439	836	3716	2603	1.947
2.40	1689	1124	1755	3444	845	3724	2599	1.963
2.50	1712	1133	1745	3458	856	3734	2602	1.981
2.60	1735	1154	1725	3461	868	3747	2593	2.006
2.70	1752	1170	1709	3461	876	3755	2585	2.025
2.80	1768	1191	1689	3457	884	3764	2573	2.047
2.90	1785	1204	1676	3461	892	3773	2569	2.065
3.00	1807	1218	1662	3470	904	3784	2566	2.087
3.10	1818	1232	1647	3465	909	3788	2556	2.104
3.20	1834	1247	1632	3466	917	3796	2549	2.124
3.30	1851	1259	1620	3471	925	3804	2545	2.142
3.40	1861	1272	1607	3468	930	3809	2538	2.158
3.50	1871	1285	1594	3465	935	3814	2530	2.173
3.60	1887	1295	1584	3471	944	3823	2527	2.192
3.70	1897	1305	1574	3471	949	3828	2523	2.205
3.80	1907	1313	1566	3473	954	3833	2520	2.218
3.90	1923	1322	1556	3479	962	3840	2517	2.236
4.00	1933	1329	1550	3483	967	3846	2516	2.247
4.10	1943	1336	1544	3487	971	3852	2515	2.259
4.20	1953	1343	1536	3489	977	3856	2512	2.272
4.30	1963	1350	1530	3493	981	3862	2511	2.283
4.40	1973	1356	1523	3496	986	3865	2509	2.295
4.50	1983	1361	1518	3501	991	3870	2509	2.306
4.60	1992	1366	1513	3506	996	3875	2510	2.316
4.70	2002	1370	1510	3512	1001	3881	2511	2.326
4.80	2012	1372	1508	3519	1006	3885	2514	2.334
4.90	2015	1370	1509	3524	1008	3887	2516	2.336
5.00	2025	1369	1510	3535	1013	3892	2522	2.341
5.10	2035	1375	1505	3540	1017	3898	2523	2.352
5.20	2044	1381	1499	3544	1022	3902	2522	2.363

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
5.30	2048	1386	1495	3542	1024	3904	2519	2.370
5.40	2051	1391	1489	3540	1026	3906	2514	2.378
5.50	2061	1395	1484	3545	1031	3910	2515	2.389
5.60	2064	1401	1478	3543	1032	3911	2511	2.396
5.70	2074	1405	1474	3548	1037	3916	2511	2.407
5.80	2077	1409	1470	3547	1039	3918	2509	2.413
5.90	2081	1414	1467	3547	1040	3921	2507	2.419
6.00	2096	1416	1463	3559	1048	3927	2511	2.433
6.10	2100	1420	1460	3559	1050	3929	2509	2.439
6.20	2109	1423	1456	3565	1055	3934	2511	2.449
6.30	2106	1424	1456	3562	1053	3933	2509	2.447
6.40	2122	1427	1454	3575	1061	3941	2515	2.460
6.50	2125	1429	1450	3575	1063	3942	2513	2.465
6.60	2128	1430	1450	3578	1064	3944	2514	2.468
6.70	2132	1431	1449	3581	1066	3946	2515	2.471
6.80	2135	1431	1449	3584	1067	3948	2516	2.473
6.90	2138	1432	1447	3585	1069	3948	2516	2.478
7.00	2147	1434	1447	3594	1074	3954	2520	2.484
7.10	2151	1434	1446	3596	1075	3954	2521	2.488
7.20	2154	1434	1447	3601	1077	3957	2524	2.489
7.30	2163	1434	1446	3609	1082	3961	2527	2.497
7.40	2166	1434	1446	3612	1083	3962	2529	2.499
7.50	2170	1435	1444	3614	1085	3964	2529	2.502
7.60	2173	1435	1444	3617	1086	3965	2531	2.504
7.70	2176	1435	1444	3620	1088	3967	2532	2.507
7.80	2185	1436	1443	3628	1093	3972	2536	2.514
7.90	2188	1436	1443	3631	1094	3973	2537	2.516
8.00	2185	1437	1442	3627	1093	3972	2535	2.515
8.10	2188	1437	1442	3630	1094	3973	2536	2.518
8.20	2197	1437	1443	3640	1099	3979	2542	2.523
8.30	2200	1437	1442	3642	1100	3979	2542	2.526
8.40	2204	1437	1442	3646	1102	3981	2544	2.528
8.50	2206	1437	1443	3650	1103	3983	2546	2.529
8.60	2210	1436	1443	3653	1105	3984	2548	2.531
8.70	2219	1436	1443	3662	1109	3988	2552	2.537
8.80	2216	1436	1443	3659	1108	3987	2551	2.535
8.90	2219	1436	1444	3663	1109	3990	2554	2.536
9.00	2222	1435	1444	3666	1111	3990	2555	2.538
9.10	2231	1434	1446	3676	1115	3994	2561	2.543
9.20	2228	1434	1446	3673	1114	3993	2559	2.541
9.30	2231	1434	1446	3676	1115	3994	2561	2.543
9.40	2233	1434	1447	3680	1117	3997	2563	2.544
9.50	2236	1432	1447	3683	1118	3997	2565	2.546
9.60	2239	1432	1447	3686	1120	3999	2566	2.548
9.70	2236	1432	1447	3683	1118	3997	2565	2.546
9.80	2245	1432	1448	3693	1123	4003	2570	2.551
9.90	2248	1432	1448	3696	1124	4004	2572	2.553
10.00	2251	1431	1449	3700	1125	4006	2574	2.553
10.10	2254	1430	1450	3704	1127	4007	2577	2.554
10.20	2257	1430	1450	3707	1128	4008	2578	2.556
10.30	2254	1429	1450	3704	1127	4006	2577	2.554
10.40	2262	1430	1450	3712	1131	4011	2581	2.560
10.50	2265	1429	1450	3715	1133	4012	2583	2.562
10.60	2262	1429	1451	3713	1131	4011	2582	2.559
10.70	2265	1429	1451	3716	1132	4013	2584	2.560
10.80	2268	1429	1451	3719	1134	4014	2585	2.562
10.90	2270	1429	1451	3722	1135	4015	2587	2.564
11.00	2273	1428	1451	3725	1137	4016	2588	2.566
11.10	2270	1428	1451	3722	1135	4014	2587	2.564
11.20	2273	1428	1451	3724	1137	4016	2588	2.566
11.30	2276	1428	1451	3727	1138	4017	2589	2.568
11.40	2278	1427	1453	3731	1139	4018	2592	2.569
11.50	2281	1425	1454	3735	1141	4020	2594	2.569
11.60	2284	1425	1454	3738	1142	4021	2596	2.571

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
11.70	2281	1424	1455	3736	1140	4020	2595	2.568
11.80	2284	1424	1455	3738	1142	4021	2597	2.570
11.90	2286	1422	1457	3743	1143	4022	2600	2.569
12.00	2289	1420	1460	3748	1144	4024	2604	2.568
12.10	2286	1417	1462	3748	1143	4022	2605	2.564
12.20	2288	1415	1465	3754	1144	4024	2610	2.562
12.30	2291	1414	1465	3757	1146	4025	2611	2.563
12.40	2294	1415	1464	3758	1147	4026	2611	2.567
12.50	2296	1414	1465	3762	1148	4027	2614	2.567
12.60	2299	1414	1465	3764	1149	4028	2615	2.569
12.70	2296	1411	1468	3764	1148	4027	2616	2.564
12.80	2298	1407	1474	3772	1149	4029	2623	2.560
12.90	2301	1402	1477	3778	1151	4030	2628	2.558
13.00	2303	1402	1477	3781	1152	4031	2629	2.559
13.10	2312	1401	1478	3790	1156	4035	2634	2.564
13.20	2309	1400	1479	3788	1154	4033	2634	2.560
13.30	2305	1400	1481	3786	1153	4033	2633	2.557
13.40	2308	1398	1481	3789	1154	4033	2635	2.559
13.50	2316	1397	1482	3798	1158	4037	2640	2.563
13.60	2319	1397	1482	3800	1159	4038	2641	2.565
13.70	2315	1396	1484	3799	1158	4038	2642	2.560
13.80	2318	1395	1484	3802	1159	4038	2643	2.562
13.90	2320	1395	1484	3805	1160	4039	2644	2.563
14.00	2323	1393	1487	3809	1161	4040	2648	2.563
14.10	2325	1390	1490	3815	1163	4043	2653	2.560
14.20	2328	1390	1489	3816	1164	4043	2653	2.563
14.30	2330	1389	1490	3820	1165	4044	2655	2.564
14.40	2332	1388	1491	3824	1166	4045	2657	2.564
14.50	2329	1387	1494	3823	1165	4045	2658	2.559
14.60	2337	1386	1494	3831	1169	4048	2662	2.565
14.70	2334	1384	1495	3829	1167	4046	2662	2.562
14.80	2342	1383	1496	3838	1171	4050	2667	2.566
14.90	2344	1383	1496	3840	1172	4051	2668	2.567
15.00	2346	1382	1497	3844	1173	4052	2670	2.567
15.10	2349	1382	1498	3847	1174	4055	2673	2.568
15.20	2345	1382	1498	3844	1173	4053	2671	2.566
15.30	2348	1381	1499	3847	1174	4054	2673	2.566
15.40	2350	1381	1498	3848	1175	4054	2673	2.569
15.50	2352	1380	1499	3852	1176	4055	2676	2.569
15.60	2355	1380	1499	3854	1177	4056	2677	2.570
15.70	2351	1379	1501	3852	1176	4055	2676	2.567
15.80	2359	1379	1502	3861	1180	4060	2681	2.571
15.90	2356	1376	1503	3859	1178	4057	2681	2.568
16.00	2358	1375	1504	3862	1179	4058	2683	2.568
16.10	2360	1375	1505	3865	1180	4060	2685	2.568
16.20	2362	1374	1505	3868	1181	4060	2687	2.570
16.30	2365	1374	1506	3871	1182	4063	2689	2.570
16.40	2361	1372	1508	3869	1181	4060	2688	2.566
16.50	2358	1370	1509	3867	1179	4058	2688	2.563
16.60	2360	1369	1510	3870	1180	4059	2690	2.563
16.70	2368	1368	1511	3879	1184	4063	2695	2.567
16.80	2365	1367	1512	3877	1182	4061	2695	2.564
16.90	2372	1364	1515	3887	1186	4065	2701	2.566
17.00	2369	1363	1517	3886	1184	4065	2701	2.561
17.10	2371	1362	1518	3889	1185	4066	2704	2.562
17.20	2367	1361	1519	3887	1184	4064	2703	2.558
17.30	2370	1359	1520	3890	1185	4064	2705	2.559
17.40	2372	1357	1522	3893	1186	4065	2708	2.559
17.50	2368	1356	1524	3892	1184	4064	2708	2.554
17.60	2371	1355	1524	3895	1185	4064	2709	2.556
17.70	2367	1354	1526	3893	1184	4064	2710	2.551
17.80	2369	1352	1528	3897	1185	4064	2712	2.551
17.90	2366	1352	1529	3895	1183	4063	2712	2.548
18.00	2368	1350	1529	3897	1184	4063	2713	2.549

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
18.10	2370	1349	1530	3900	1185	4064	2715	2.549
18.20	2372	1349	1530	3902	1186	4065	2716	2.550
18.30	2379	1348	1531	3910	1190	4069	2721	2.554
18.40	2376	1347	1533	3909	1188	4068	2721	2.549
18.50	2383	1346	1535	3918	1192	4072	2726	2.553
18.60	2385	1345	1536	3921	1192	4073	2728	2.553
18.70	2387	1343	1536	3923	1194	4073	2729	2.554
18.80	2389	1341	1538	3927	1194	4074	2733	2.553
18.90	2385	1340	1540	3926	1193	4073	2733	2.549
19.00	2387	1339	1542	3929	1194	4074	2735	2.549
19.10	2389	1338	1542	3931	1195	4074	2736	2.550
19.20	2391	1336	1543	3934	1196	4075	2738	2.550
19.30	2388	1334	1545	3933	1194	4073	2739	2.545
19.40	2389	1333	1547	3937	1195	4075	2742	2.544
19.50	2392	1332	1547	3939	1196	4075	2743	2.546
19.60	2388	1331	1549	3937	1194	4073	2743	2.542
19.70	2390	1328	1551	3941	1195	4074	2746	2.541
19.80	2392	1326	1554	3946	1196	4076	2750	2.539
19.90	2388	1325	1554	3943	1194	4073	2749	2.537
20.00	2390	1323	1556	3946	1195	4074	2751	2.537

Project Name: Taylor Geo-Engineering
Project Number: M00991-001
Sample: CH-5-48
Comments: Samples were compacted to 90% of ASTM D698 at
Test Number: S2

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Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
0.00	-26	0	5761	5735	-13	5748	5748	1.005
0.02	270	45	5717	5987	135	5897	5852	1.047
0.04	450	85	5676	6127	225	5987	5902	1.079
0.06	587	123	5639	6226	294	6055	5933	1.104
0.08	695	155	5607	6303	348	6110	5955	1.124
0.10	782	184	5578	6360	391	6153	5969	1.140
0.20	1090	306	5456	6547	545	6307	6001	1.200
0.30	1298	391	5371	6668	649	6411	6020	1.242
0.40	1476	354	5408	6884	738	6500	6146	1.273
0.50	1618	258	5504	7122	809	6571	6313	1.294
0.60	1745	289	5473	7217	872	6634	6345	1.319
0.70	1857	362	5399	7256	929	6689	6328	1.344
0.80	1955	409	5353	7308	978	6739	6331	1.365
0.90	2053	449	5313	7366	1026	6788	6340	1.386
1.00	2136	341	5421	7557	1068	6830	6489	1.394
1.10	2219	390	5372	7591	1110	6871	6481	1.413
1.20	2295	453	5309	7603	1147	6909	6456	1.432
1.30	2370	512	5251	7621	1185	6948	6436	1.451
1.40	2431	543	5220	7651	1216	6979	6435	1.466
1.50	2493	565	5197	7690	1246	7008	6444	1.480
1.60	2539	597	5165	7704	1270	7032	6434	1.492
1.70	2600	627	5134	7734	1300	7061	6434	1.506
1.80	2660	672	5091	7751	1330	7093	6421	1.523
1.90	2707	703	5059	7766	1354	7115	6413	1.535
2.00	2760	734	5028	7788	1380	7142	6408	1.549
2.10	2799	766	4996	7795	1400	7162	6396	1.560
2.20	2845	801	4961	7806	1423	7185	6384	1.574
2.30	2884	834	4929	7813	1442	7205	6371	1.585
2.40	2923	863	4899	7822	1462	7223	6360	1.597
2.50	2955	898	4864	7819	1477	7239	6341	1.608
2.60	2986	940	4821	7808	1493	7255	6315	1.619
2.70	3018	984	4779	7797	1509	7272	6288	1.631
2.80	3056	1034	4728	7784	1528	7290	6256	1.647
2.90	3088	1092	4670	7758	1544	7306	6214	1.661
3.00	3119	1163	4600	7719	1560	7323	6160	1.678
3.10	3143	1225	4537	7680	1572	7334	6109	1.693
3.20	3175	1287	4475	7649	1587	7349	6062	1.709
3.30	3206	1353	4409	7615	1603	7365	6012	1.727
3.40	3230	1421	4340	7570	1615	7376	5955	1.744
3.50	3261	1494	4268	7528	1630	7392	5898	1.764
3.60	3278	1564	4198	7476	1639	7401	5837	1.781
3.70	3309	1630	4132	7440	1654	7416	5786	1.801
3.80	3332	1691	4071	7403	1666	7428	5737	1.819
3.90	3356	1743	4020	7376	1678	7441	5698	1.835
4.00	3380	1788	3974	7353	1690	7452	5664	1.851
4.10	3397	1826	3936	7333	1698	7460	5634	1.863
4.20	3413	1862	3900	7313	1707	7469	5606	1.875
4.30	3437	1909	3854	7291	1718	7481	5572	1.892
4.40	3446	1952	3811	7257	1723	7486	5534	1.904
4.50	3470	1996	3766	7236	1735	7497	5501	1.921
4.60	3487	2038	3724	7211	1743	7505	5467	1.936
4.70	3496	2074	3688	7184	1748	7510	5436	1.948
4.80	3513	2106	3656	7169	1756	7518	5412	1.961
4.90	3536	2137	3625	7160	1768	7530	5392	1.976
5.00	3545	2169	3593	7138	1773	7535	5366	1.987
5.10	3555	2197	3565	7120	1777	7539	5342	1.997
5.20	3571	2235	3529	7099	1785	7548	5314	2.012

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
5.30	3587	2265	3498	7085	1794	7557	5292	2.025
5.40	3597	2296	3466	7063	1798	7560	5265	2.038
5.50	3613	2323	3439	7052	1806	7568	5246	2.050
5.60	3629	2348	3414	7042	1814	7576	5228	2.063
5.70	3638	2365	3397	7035	1819	7581	5216	2.071
5.80	3647	2386	3376	7023	1824	7586	5200	2.080
5.90	3663	2406	3356	7020	1832	7594	5188	2.091
6.00	3665	2427	3336	7002	1833	7596	5169	2.099
6.10	3675	2451	3312	6986	1837	7600	5149	2.110
6.20	3684	2476	3287	6971	1842	7605	5129	2.121
6.30	3700	2499	3264	6963	1850	7613	5114	2.134
6.40	3702	2520	3243	6945	1851	7614	5094	2.142
6.50	3718	2532	3230	6948	1859	7621	5089	2.151
6.60	3720	2545	3217	6937	1860	7622	5077	2.156
6.70	3722	2557	3205	6928	1861	7623	5066	2.161
6.80	3738	2572	3190	6928	1869	7631	5059	2.172
6.90	3740	2594	3169	6909	1870	7633	5039	2.180
7.00	3749	2613	3150	6899	1874	7638	5025	2.190
7.10	3758	2629	3134	6892	1879	7642	5013	2.199
7.20	3767	2643	3120	6886	1883	7646	5003	2.207
7.30	3769	2655	3107	6876	1884	7646	4991	2.213
7.40	3771	2661	3102	6873	1885	7648	4988	2.216
7.50	3773	2669	3093	6866	1887	7648	4979	2.220
7.60	3782	2680	3082	6864	1891	7653	4973	2.227
7.70	3790	2690	3073	6863	1895	7658	4968	2.233
7.80	3792	2705	3058	6850	1896	7659	4954	2.240
7.90	3801	2722	3041	6842	1901	7664	4942	2.250
8.00	3803	2738	3024	6827	1902	7664	4925	2.258
8.10	3812	2752	3011	6823	1906	7669	4917	2.266
8.20	3814	2756	3006	6820	1907	7669	4913	2.269
8.30	3822	2761	3001	6824	1911	7673	4913	2.274
8.40	3824	2766	2996	6820	1912	7674	4908	2.277
8.50	3833	2773	2989	6821	1916	7678	4905	2.283
8.60	3835	2785	2978	6813	1917	7680	4895	2.288
8.70	3843	2799	2963	6806	1922	7684	4884	2.297
8.80	3851	2806	2957	6808	1926	7689	4883	2.303
8.90	3853	2814	2949	6802	1927	7690	4875	2.307
9.00	3862	2821	2942	6804	1931	7694	4873	2.313
9.10	3864	2828	2934	6797	1932	7694	4865	2.317
9.20	3872	2831	2932	6804	1936	7699	4868	2.320
9.30	3874	2828	2934	6807	1937	7699	4870	2.321
9.40	3889	2833	2929	6818	1944	7706	4873	2.328
9.50	3884	2840	2923	6807	1942	7705	4865	2.329
9.60	3892	2852	2910	6802	1946	7708	4856	2.338
9.70	3894	2866	2896	6790	1947	7709	4843	2.345
9.80	3902	2875	2888	6790	1951	7714	4839	2.351
9.90	3910	2886	2876	6786	1955	7717	4831	2.360
10.00	3912	2894	2869	6781	1956	7719	4825	2.363
10.10	3920	2902	2860	6780	1960	7722	4820	2.371
10.20	3915	2908	2854	6769	1958	7720	4812	2.372
10.30	3930	2914	2849	6779	1965	7728	4814	2.379
10.40	3925	2916	2845	6770	1963	7723	4807	2.380
10.50	3933	2921	2841	6774	1967	7728	4808	2.384
10.60	3935	2915	2847	6781	1967	7729	4814	2.382
10.70	3936	2913	2849	6785	1968	7730	4817	2.381
10.80	3938	2913	2849	6787	1969	7731	4818	2.382
10.90	3939	2921	2842	6781	1970	7733	4812	2.386
11.00	3947	2929	2833	6780	1974	7735	4806	2.393
11.10	3949	2935	2827	6776	1974	7736	4801	2.397
11.20	3943	2940	2823	6767	1972	7735	4795	2.397
11.30	3958	2946	2818	6775	1979	7742	4796	2.405
11.40	3953	2948	2815	6768	1976	7740	4792	2.404
11.50	3961	2953	2809	6770	1980	7742	4790	2.410
11.60	3956	2955	2807	6763	1978	7740	4785	2.409

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
11.70	3964	2954	2808	6772	1982	7744	4790	2.411
11.80	3965	2955	2807	6772	1982	7744	4790	2.413
11.90	3966	2957	2805	6771	1983	7745	4788	2.414
12.00	3968	2962	2800	6768	1984	7746	4784	2.417
12.10	3969	2951	2811	6780	1985	7746	4795	2.412
12.20	3970	2944	2818	6788	1985	7747	4803	2.409
12.30	3971	2942	2821	6793	1986	7749	4807	2.408
12.40	3973	2953	2809	6782	1987	7748	4796	2.414
12.50	3974	2962	2800	6774	1987	7749	4787	2.419
12.60	3976	2965	2797	6772	1988	7750	4784	2.422
12.70	3977	2970	2792	6769	1988	7750	4780	2.424
12.80	3972	2976	2786	6758	1986	7748	4772	2.426
12.90	3973	2980	2784	6756	1986	7750	4770	2.427
13.00	3974	2982	2781	6755	1987	7750	4768	2.429
13.10	3975	2985	2777	6752	1988	7750	4764	2.432
13.20	3977	2985	2777	6753	1988	7750	4765	2.432
13.30	3978	2987	2777	6754	1989	7752	4765	2.433
13.40	3979	2985	2778	6757	1989	7752	4767	2.432
13.50	3974	2978	2784	6758	1987	7749	4771	2.428
13.60	3975	2968	2793	6768	1988	7748	4781	2.423
13.70	3976	2961	2800	6776	1988	7749	4788	2.420
13.80	3977	2970	2792	6769	1989	7751	4781	2.425
13.90	3985	2976	2786	6771	1992	7754	4778	2.430
14.00	3986	2983	2780	6766	1993	7756	4773	2.434
14.10	3987	2985	2778	6765	1993	7756	4771	2.435
14.20	3988	2989	2773	6761	1994	7756	4767	2.438
14.30	3995	2991	2772	6767	1998	7761	4769	2.441
14.40	3990	2994	2768	6758	1995	7757	4763	2.441
14.50	3991	2994	2768	6760	1996	7757	4764	2.442
14.60	3998	2997	2765	6763	1999	7761	4764	2.446
14.70	3999	2998	2764	6763	2000	7762	4763	2.447
14.80	4000	2997	2765	6765	2000	7762	4765	2.447
14.90	4007	2997	2766	6773	2004	7767	4770	2.449
15.00	4008	2996	2766	6774	2004	7766	4770	2.449
15.10	4009	2987	2775	6785	2005	7767	4780	2.445
15.20	4010	2976	2786	6796	2005	7767	4791	2.439
15.30	4017	2974	2788	6806	2009	7771	4797	2.441
15.40	4018	2983	2779	6797	2009	7771	4788	2.446
15.50	4013	2991	2771	6784	2006	7768	4777	2.448
15.60	4020	2997	2765	6785	2010	7772	4775	2.454
15.70	4014	3001	2763	6777	2007	7770	4770	2.453
15.80	4015	3006	2757	6772	2008	7771	4764	2.457
15.90	4022	3010	2752	6774	2011	7773	4763	2.462
16.00	4017	3015	2747	6764	2009	7770	4756	2.462
16.10	4018	3017	2745	6763	2009	7771	4754	2.464
16.20	4019	3018	2744	6763	2009	7771	4753	2.465
16.30	4019	3017	2745	6764	2010	7772	4755	2.464
16.40	4020	3018	2744	6764	2010	7772	4754	2.465
16.50	4021	3019	2743	6764	2011	7772	4753	2.466
16.60	4022	3015	2747	6769	2011	7773	4758	2.464
16.70	4016	3013	2748	6765	2008	7770	4757	2.461
16.80	4023	3013	2750	6773	2012	7775	4761	2.463
16.90	4018	3012	2750	6768	2009	7771	4759	2.461
17.00	4013	3010	2752	6765	2006	7768	4758	2.458
17.10	4019	2999	2763	6782	2010	7772	4772	2.455
17.20	4014	2994	2768	6782	2007	7769	4775	2.450
17.30	4009	2989	2773	6782	2004	7766	4777	2.446
17.40	4009	2996	2766	6775	2005	7767	4771	2.449
17.50	4010	3004	2758	6768	2005	7767	4763	2.454
17.60	4011	3022	2740	6751	2005	7767	4746	2.464
17.70	4011	3045	2718	6729	2006	7769	4724	2.476
17.80	4012	3058	2704	6716	2006	7768	4710	2.484
17.90	4006	3052	2711	6717	2003	7766	4714	2.478
18.00	4001	3046	2716	6717	2001	7762	4716	2.473

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
18.10	3996	3025	2737	6732	1998	7760	4735	2.460
18.20	4002	3012	2750	6752	2001	7763	4751	2.456
18.30	4003	2997	2765	6768	2001	7763	4766	2.448
18.40	4003	2985	2777	6780	2002	7764	4778	2.442
18.50	3998	2956	2806	6804	1999	7761	4805	2.425
18.60	3998	2939	2823	6822	1999	7761	4823	2.416
18.70	3993	2923	2839	6832	1997	7758	4835	2.407
18.80	3999	2912	2850	6850	2000	7762	4850	2.403
18.90	4000	2866	2895	6895	2000	7761	4895	2.382
19.00	3995	2833	2929	6923	1997	7759	4926	2.364
19.10	4001	2817	2944	6945	2001	7761	4945	2.359
19.20	4007	2810	2951	6958	2004	7764	4955	2.358
19.30	4007	2821	2941	6948	2004	7766	4944	2.363
19.40	4008	2834	2929	6937	2004	7767	4933	2.368
19.50	4014	2854	2908	6922	2007	7769	4915	2.381
19.60	4020	2871	2893	6913	2010	7773	4903	2.390
19.70	4021	2889	2873	6893	2010	7772	4883	2.400
19.80	4021	2907	2855	6876	2011	7772	4866	2.408
19.90	4021	2924	2838	6859	2011	7773	4848	2.417
20.00	4022	2943	2819	6840	2011	7773	4830	2.427

Project Name: Taylor Geo-Engineering
Project Number: M00991-001
Sample: CH-5-48
Comments: Samples were compacted to 90% of ASTM D698 at
Test Number: S3

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Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
0.00	-47	0	11524	11477	-23	11500	11500	1.004
0.02	511	43	11480	11992	256	11779	11736	1.045
0.04	829	82	11442	12271	415	11938	11856	1.072
0.06	1054	116	11408	12461	527	12050	11934	1.092
0.08	1247	150	11374	12621	624	12147	11997	1.110
0.10	1394	179	11344	12738	697	12220	12041	1.123
0.20	1949	307	11217	13166	975	12498	12191	1.174
0.30	2333	328	11196	13529	1167	12690	12362	1.208
0.40	2632	288	11235	13867	1316	12839	12551	1.234
0.50	2891	391	11132	14023	1446	12969	12578	1.260
0.60	3119	519	11005	14124	1559	13083	12564	1.283
0.70	3323	650	10875	14198	1662	13186	12536	1.306
0.80	3512	789	10734	14246	1756	13279	12490	1.327
0.90	3684	922	10602	14286	1842	13366	12444	1.348
1.00	3857	1048	10475	14332	1928	13452	12404	1.368
1.10	3998	1168	10356	14354	1999	13523	12355	1.386
1.20	4139	1287	10236	14375	2069	13593	12306	1.404
1.30	4272	1402	10123	14395	2136	13661	12259	1.422
1.40	4405	1505	10019	14423	2202	13726	12221	1.440
1.50	4514	1627	9897	14411	2257	13781	12154	1.456
1.60	4631	1733	9790	14421	2316	13839	12106	1.473
1.70	4733	1846	9678	14410	2366	13890	12044	1.489
1.80	4834	1956	9568	14402	2417	13941	11985	1.505
1.90	4935	2071	9453	14388	2468	13991	11920	1.522
2.00	5021	2169	9355	14375	2510	14034	11865	1.537
2.10	5114	2259	9264	14378	2557	14080	11821	1.552
2.20	5199	2373	9151	14350	2599	14123	11750	1.568
2.30	5276	2478	9045	14322	2638	14161	11683	1.583
2.40	5354	2583	8941	14295	2677	14201	11618	1.599
2.50	5431	2679	8846	14277	2715	14240	11561	1.614
2.60	5493	2771	8753	14245	2746	14270	11499	1.628
2.70	5562	2861	8664	14225	2781	14305	11444	1.642
2.80	5623	2951	8572	14196	2812	14335	11384	1.656
2.90	5677	3035	8490	14167	2839	14364	11329	1.669
3.00	5746	3113	8411	14157	2873	14397	11284	1.683
3.10	5800	3190	8333	14133	2900	14423	11233	1.696
3.20	5846	3269	8255	14101	2923	14447	11178	1.708
3.30	5899	3343	8181	14080	2950	14474	11131	1.721
3.40	5952	3416	8108	14061	2976	14500	11084	1.734
3.50	5991	3493	8031	14022	2995	14519	11026	1.746
3.60	6036	3566	7957	13994	3018	14541	10975	1.759
3.70	6082	3637	7887	13969	3041	14565	10928	1.771
3.80	6127	3706	7818	13945	3064	14587	10881	1.784
3.90	6165	3775	7749	13914	3082	14606	10831	1.796
4.00	6203	3839	7684	13887	3101	14625	10786	1.807
4.10	6240	3902	7621	13861	3120	14643	10741	1.819
4.20	6270	3961	7563	13833	3135	14659	10698	1.829
4.30	6308	4018	7505	13813	3154	14677	10659	1.840
4.40	6345	4078	7447	13791	3172	14697	10619	1.852
4.50	6375	4130	7395	13770	3187	14712	10582	1.862
4.60	6405	4179	7345	13749	3202	14726	10547	1.872
4.70	6442	4233	7291	13733	3221	14745	10512	1.884
4.80	6464	4283	7241	13704	3232	14755	10472	1.893
4.90	6486	4335	7189	13675	3243	14767	10432	1.902
5.00	6523	4384	7140	13663	3261	14785	10401	1.914
5.10	6538	4434	7089	13627	3269	14792	10358	1.922
5.20	6560	4483	7040	13600	3280	14803	10320	1.932

Axial strain, ε (%)	σd ($\sigma 1-\sigma 3$) (psf)	Δ pore press., Δu (psf)	Effective $\sigma'3$ (psf)	Effective $\sigma'1$ (psf)	q ($\sigma 1-\sigma 3$)/2 (psf)	p ($\sigma 1+\sigma 3$)/2 (psf)	p' ($\sigma'1+\sigma'3$)/2 (psf)	$\sigma'1/\sigma'3$
5.30	6589	4534	6990	13579	3294	14818	10284	1.943
5.40	6611	4582	6942	13552	3305	14829	10247	1.952
5.50	6625	4627	6897	13522	3313	14837	10210	1.960
5.60	6654	4672	6852	13506	3327	14851	10179	1.971
5.70	6676	4715	6808	13484	3338	14861	10146	1.981
5.80	6690	4755	6769	13459	3345	14869	10114	1.988
5.90	6711	4798	6726	13438	3356	14880	10082	1.998
6.00	6733	4841	6684	13417	3366	14892	10051	2.007
6.10	6747	4882	6643	13390	3374	14899	10017	2.016
6.20	6769	4919	6605	13373	3384	14908	9989	2.025
6.30	6782	4960	6565	13347	3391	14916	9956	2.033
6.40	6797	4997	6526	13323	3398	14922	9924	2.041
6.50	6810	5033	6491	13301	3405	14929	9896	2.049
6.60	6832	5067	6457	13289	3416	14939	9873	2.058
6.70	6845	5098	6427	13272	3423	14947	9849	2.065
6.80	6852	5129	6395	13247	3426	14950	9821	2.071
6.90	6866	5157	6368	13234	3433	14958	9801	2.078
7.00	6879	5187	6338	13217	3440	14964	9777	2.085
7.10	6893	5219	6305	13198	3447	14970	9751	2.093
7.20	6907	5246	6279	13186	3453	14978	9732	2.100
7.30	6920	5273	6251	13171	3460	14984	9711	2.107
7.40	6934	5297	6227	13161	3467	14992	9694	2.113
7.50	6940	5322	6203	13143	3470	14995	9673	2.119
7.60	6947	5345	6178	13125	3473	14997	9652	2.124
7.70	6960	5371	6154	13113	3480	15005	9634	2.131
7.80	6966	5393	6130	13096	3483	15007	9613	2.136
7.90	6987	5421	6103	13090	3493	15018	9597	2.145
8.00	6986	5444	6080	13066	3493	15016	9573	2.149
8.10	6999	5466	6058	13057	3500	15023	9557	2.155
8.20	7005	5491	6033	13038	3503	15026	9536	2.161
8.30	7018	5512	6013	13031	3509	15034	9522	2.167
8.40	7024	5533	5991	13015	3512	15036	9503	2.172
8.50	7037	5554	5970	13007	3519	15042	9488	2.179
8.60	7050	5575	5949	12999	3525	15049	9474	2.185
8.70	7056	5597	5928	12984	3528	15053	9456	2.190
8.80	7055	5618	5905	12960	3528	15051	9433	2.195
8.90	7068	5638	5886	12953	3534	15058	9419	2.201
9.00	7074	5659	5864	12938	3537	15060	9401	2.206
9.10	7073	5680	5843	12916	3536	15060	9380	2.210
9.20	7085	5699	5826	12911	3543	15067	9368	2.216
9.30	7091	5718	5806	12897	3546	15069	9351	2.221
9.40	7097	5736	5787	12884	3548	15072	9336	2.226
9.50	7102	5755	5770	12872	3551	15076	9321	2.231
9.60	7115	5770	5754	12869	3558	15082	9312	2.236
9.70	7114	5787	5737	12850	3557	15080	9294	2.240
9.80	7126	5803	5722	12848	3563	15088	9285	2.245
9.90	7132	5817	5707	12839	3566	15091	9273	2.250
10.00	7130	5829	5696	12826	3565	15090	9261	2.252
10.10	7136	5841	5683	12819	3568	15092	9251	2.256
10.20	7141	5855	5669	12810	3571	15094	9239	2.260
10.30	7140	5865	5659	12799	3570	15095	9229	2.262
10.40	7145	5876	5648	12793	3573	15096	9220	2.265
10.50	7151	5884	5640	12790	3575	15099	9215	2.268
10.60	7156	5895	5629	12785	3578	15102	9207	2.271
10.70	7161	5903	5622	12783	3581	15105	9203	2.274
10.80	7166	5913	5611	12778	3583	15108	9195	2.277
10.90	7172	5920	5604	12776	3586	15111	9190	2.280
11.00	7170	5926	5597	12768	3585	15109	9183	2.281
11.10	7175	5932	5593	12768	3588	15112	9180	2.283
11.20	7174	5938	5586	12759	3587	15110	9173	2.284
11.30	7186	5944	5580	12765	3593	15116	9173	2.288
11.40	7191	5948	5576	12767	3595	15120	9172	2.290
11.50	7189	5954	5569	12758	3595	15118	9164	2.291
11.60	7194	5957	5568	12762	3597	15122	9165	2.292

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
11.70	7192	5961	5562	12755	3596	15120	9158	2.293
11.80	7197	5964	5560	12757	3599	15122	9159	2.295
11.90	7202	5967	5556	12759	3601	15125	9158	2.296
12.00	7207	5968	5555	12763	3604	15127	9159	2.297
12.10	7205	5972	5552	12757	3603	15126	9154	2.298
12.20	7210	5971	5554	12764	3605	15130	9159	2.298
12.30	7215	5971	5553	12768	3608	15131	9160	2.299
12.40	7220	5971	5553	12773	3610	15134	9163	2.300
12.50	7218	5971	5554	12772	3609	15134	9163	2.300
12.60	7223	5970	5555	12778	3611	15136	9167	2.300
12.70	7221	5967	5556	12777	3610	15134	9167	2.300
12.80	7219	5968	5555	12774	3609	15133	9165	2.299
12.90	7224	5967	5556	12780	3612	15135	9168	2.300
13.00	7228	5966	5558	12786	3614	15138	9172	2.301
13.10	7226	5964	5561	12787	3613	15138	9174	2.299
13.20	7217	5963	5561	12778	3609	15132	9170	2.298
13.30	7215	5967	5556	12772	3608	15131	9164	2.299
13.40	7227	5966	5558	12784	3613	15137	9171	2.300
13.50	7224	5963	5561	12785	3612	15136	9173	2.299
13.60	7222	5961	5562	12784	3611	15135	9173	2.298
13.70	7233	5959	5566	12799	3617	15141	9182	2.300
13.80	7231	5957	5567	12798	3616	15139	9183	2.299
13.90	7235	5953	5572	12807	3618	15142	9189	2.299
14.00	7240	5950	5574	12814	3620	15144	9194	2.299
14.10	7238	5945	5580	12817	3619	15144	9199	2.297
14.20	7242	5938	5587	12829	3621	15146	9208	2.296
14.30	7240	5932	5590	12830	3620	15142	9210	2.295
14.40	7237	5924	5601	12838	3619	15143	9220	2.292
14.50	7242	5915	5609	12851	3621	15145	9230	2.291
14.60	7246	5903	5621	12867	3623	15147	9244	2.289
14.70	7250	5891	5634	12884	3625	15150	9259	2.287
14.80	7248	5878	5645	12893	3624	15148	9269	2.284
14.90	7252	5863	5661	12913	3626	15150	9287	2.281
15.00	7263	5849	5675	12938	3632	15155	9306	2.280
15.10	7260	5835	5690	12950	3630	15155	9320	2.276
15.20	7252	5820	5704	12955	3626	15149	9330	2.271
15.30	7255	5807	5718	12973	3628	15152	9346	2.269
15.40	7259	5793	5732	12991	3630	15154	9362	2.266
15.50	7257	5780	5744	13001	3629	15152	9372	2.263
15.60	7255	5767	5757	13011	3627	15151	9384	2.260
15.70	7259	5753	5771	13029	3629	15153	9400	2.258
15.80	7256	5740	5785	13041	3628	15153	9413	2.254
15.90	7260	5727	5798	13057	3630	15155	9428	2.252
16.00	7264	5713	5811	13074	3632	15155	9442	2.250
16.10	7261	5700	5823	13084	3631	15154	9454	2.247
16.20	7259	5687	5836	13095	3629	15153	9466	2.244
16.30	7269	5677	5847	13116	3634	15158	9481	2.243
16.40	7266	5666	5857	13123	3633	15157	9490	2.241
16.50	7263	5653	5870	13134	3632	15155	9502	2.237
16.60	7261	5642	5882	13143	3630	15154	9512	2.234
16.70	7258	5631	5893	13150	3629	15153	9522	2.232
16.80	7262	5623	5901	13162	3631	15154	9532	2.231
16.90	7265	5612	5912	13178	3633	15157	9545	2.229
17.00	7262	5602	5923	13185	3631	15156	9554	2.226
17.10	7253	5590	5934	13187	3627	15150	9560	2.222
17.20	7257	5578	5946	13203	3628	15153	9575	2.220
17.30	7261	5569	5955	13215	3630	15154	9585	2.219
17.40	7264	5558	5965	13229	3632	15156	9597	2.218
17.50	7261	5549	5975	13236	3631	15154	9605	2.215
17.60	7258	5540	5984	13242	3629	15153	9613	2.213
17.70	7262	5535	5989	13250	3631	15154	9619	2.213
17.80	7259	5525	5999	13258	3629	15153	9628	2.210
17.90	7262	5513	6011	13273	3631	15155	9642	2.208
18.00	7259	5503	6021	13280	3630	15154	9651	2.206

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
18.10	7256	5494	6031	13287	3628	15153	9659	2.203
18.20	7260	5485	6040	13300	3630	15154	9670	2.202
18.30	7263	5474	6051	13313	3631	15156	9682	2.200
18.40	7260	5465	6059	13319	3630	15153	9689	2.198
18.50	7263	5458	6066	13329	3632	15155	9697	2.197
18.60	7260	5451	6073	13333	3630	15154	9703	2.196
18.70	7257	5444	6081	13338	3628	15153	9710	2.193
18.80	7260	5439	6086	13346	3630	15155	9716	2.193
18.90	7263	5432	6093	13356	3632	15156	9724	2.192
19.00	7260	5428	6096	13356	3630	15155	9726	2.191
19.10	7270	5425	6099	13368	3635	15158	9733	2.192
19.20	7266	5417	6107	13373	3633	15157	9740	2.190
19.30	7276	5413	6110	13386	3638	15161	9748	2.191
19.40	7266	5409	6115	13381	3633	15157	9748	2.188
19.50	7269	5405	6119	13388	3635	15158	9753	2.188
19.60	7266	5403	6121	13387	3633	15157	9754	2.187
19.70	7269	5402	6122	13391	3634	15158	9757	2.187
19.80	7272	5399	6124	13396	3636	15159	9760	2.187
19.90	7275	5396	6128	13403	3637	15161	9765	2.187
20.00	7271	5393	6130	13402	3636	15159	9766	2.186

Isotropically Consolidated Undrained with Pore Pressure (CIU/PP)

IGES

Project Name: Taylor Geo-Engineering
Project Number: M00991-001
Sample: CH-5-98
Comments: Samples were compacted to 90% of ASTM D698 at OMC.

	Test Number	S1	S2	S3	
Initial	Height, H (in)	4.22	4.22	4.05	
	Diameter, D (in)	1.88	1.88	1.88	
	Moisture Content, w (%)	17.3	17.3	17.3	
	Dry Unit Weight, γd (pcf)	97.9	98.0	97.7	
	Saturation (%)	78.6	77.0	74.0	
	Void Ratio, e	0.59	0.60	0.62	
Before Shear	Moisture Content, w (%)	22.4	20.6	19.8	
	Dry Unit Weight, γd (pcf)	103.8	107.1	114.4	
	Saturation (%)	100.0	100.0	100.0	
	Void Ratio, e	0.61	0.56	0.53	
	B	0.95	0.95	0.97	
	Back pressure (psf)	5431.9	15270	6916	
	Strain rate (%/min)	0.033	0.033	0.033	
	Time to Failure (min)	603.0	606.1	603.0	
Total Stress	Strain at Failure, εf (%)	19.90	20.00	19.90	
	σ3 (psf)	2878	5754	11523	
	σ1-σ3 (psf)	2994	5436	8088	
	σ1 (psf)	5873	11190	19612	
	q = (σ1-σ3)/2 (psf)	1497	2718	4044	
	p = (σ1+σ3)/2 (psf)	4375	8472	15568	
Effective Stress	u (psf)	1353	2564	6606	
	σ'3 (psf)	1526	3190	4918	
	σ'1-σ'3 (psf)	2994	5436	8088	
	σ'1 (psf)	4520	8626	13006	
	q = (σ'1-σ'3)/2 (psf)	1497	2718	4044	
	p' = (σ'1+σ'3)/2 (psf)	3023	5908	8962	
	σ'1/σ'3	2.96	2.70	2.64	
	A = u/(σ1−σ3)	0.452	0.472	0.817	

Estimated Specific Gravity	2.70
Plastic Limit (%)	17
Liquid Limit (%)	53
Plasticity Index (%)	36

Summary of Strength Paramaters	Total Stress	Effective Stress
c (psf)	657	216
ϕ (deg)	12.9	25.4
tan ϕ	0.229	0.475

[a] Saturation set to 100% for phase calculations

Tested by:____________

Reviewed:____________

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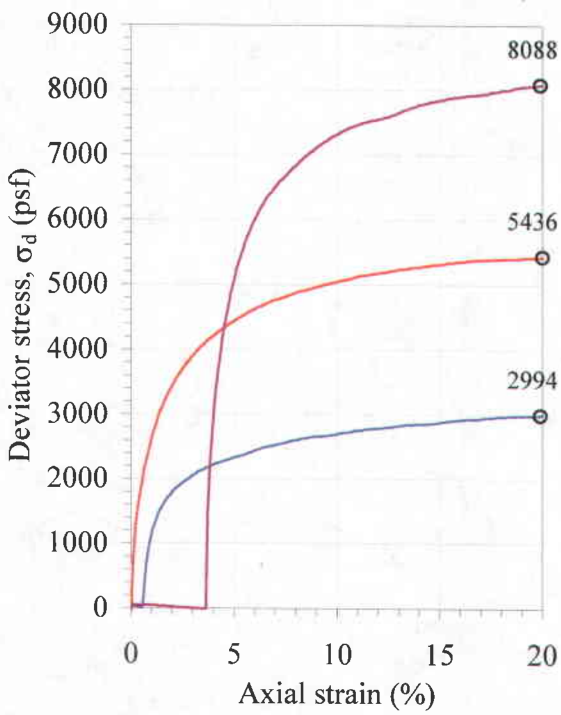
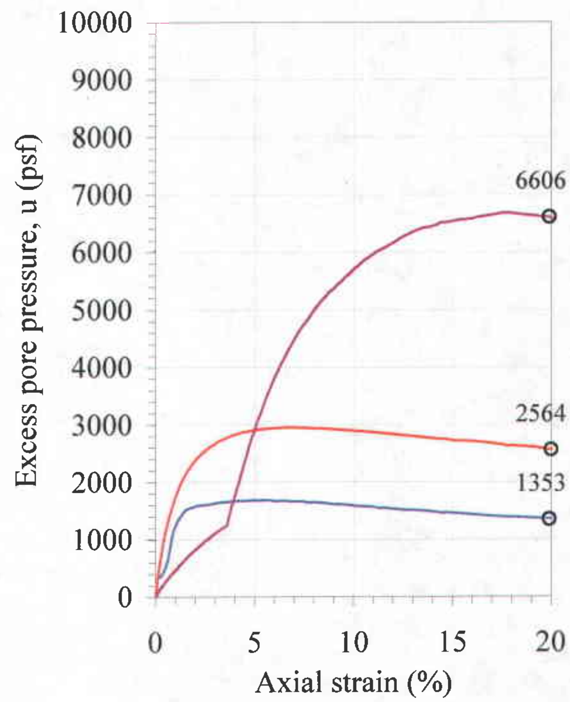
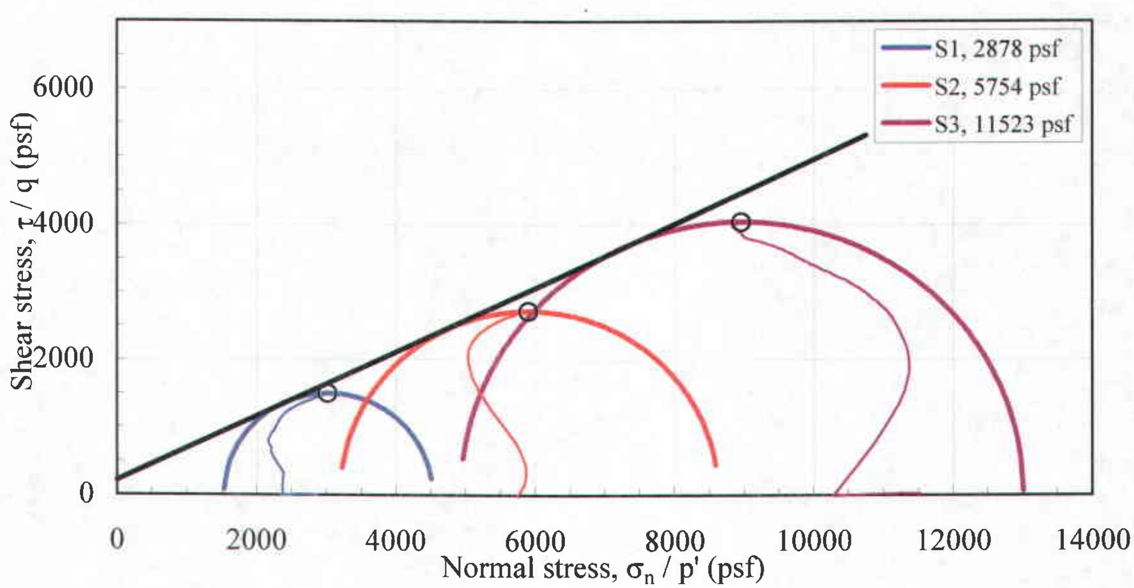
Isotropically Consolidated Undrained with Pore Pressure (CIU/PP)

Project Name: Taylor Geo-Engineering
Project Number: M00991-001
Sample: CH-5-98
Comments:

Summary of Strength Paramaters	Total Stress	Effective Stress
c (psf)	657	216
ϕ (deg)	12.9	25.4
tan ϕ	0.229	0.475







Project Name: Taylor Geo-Engineering
Project Number: M00991-001
Sample: CH-5-98
Comments: Samples were compacted to 90% of ASTM D698 at
Test Number: S1

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Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
0.00	-2	0	2878	2876	-1	2877	2877	1.001
0.02	19	107	2772	2791	10	2888	2781	1.007
0.04	19	186	2692	2711	10	2888	2702	1.007
0.06	19	248	2630	2649	10	2888	2640	1.007
0.08	19	301	2577	2596	10	2888	2587	1.007
0.10	19	335	2543	2562	9	2888	2553	1.007
0.20	11	344	2534	2545	6	2884	2540	1.004
0.30	11	382	2497	2507	5	2884	2502	1.004
0.40	3	443	2436	2439	2	2880	2437	1.001
0.50	3	513	2365	2368	1	2880	2367	1.001
0.60	256	644	2233	2489	128	3005	2361	1.115
0.70	657	827	2051	2709	329	3207	2380	1.320
0.80	889	1017	1861	2749	444	3321	2305	1.478
0.90	1049	1152	1726	2775	524	3403	2250	1.608
1.00	1181	1250	1629	2810	590	3469	2219	1.725
1.10	1285	1322	1556	2841	642	3521	2198	1.826
1.20	1381	1361	1517	2898	691	3569	2208	1.910
1.30	1456	1418	1460	2916	728	3606	2188	1.997
1.40	1524	1471	1407	2931	762	3640	2169	2.083
1.50	1585	1506	1372	2957	793	3671	2165	2.155
1.60	1632	1530	1349	2981	816	3694	2165	2.210
1.70	1678	1542	1336	3014	839	3718	2175	2.257
1.80	1725	1550	1329	3054	863	3741	2191	2.298
1.90	1758	1562	1316	3074	879	3757	2195	2.336
2.00	1797	1574	1304	3101	899	3777	2203	2.378
2.10	1829	1583	1296	3125	915	3794	2211	2.411
2.20	1862	1585	1294	3155	931	3809	2225	2.439
2.30	1887	1588	1291	3178	943	3823	2235	2.461
2.40	1912	1594	1286	3198	956	3836	2242	2.488
2.50	1938	1596	1282	3220	969	3847	2251	2.511
2.60	1963	1599	1280	3242	981	3860	2261	2.534
2.70	1981	1603	1275	3256	990	3869	2265	2.554
2.80	2006	1610	1268	3274	1003	3881	2271	2.582
2.90	2031	1617	1261	3292	1015	3894	2276	2.611
3.00	2049	1622	1256	3305	1025	3903	2281	2.631
3.10	2067	1628	1250	3317	1034	3912	2284	2.653
3.20	2099	1634	1245	3343	1049	3928	2294	2.686
3.30	2110	1639	1240	3350	1055	3933	2295	2.702
3.40	2128	1641	1238	3365	1064	3942	2301	2.719
3.50	2139	1641	1238	3376	1069	3948	2307	2.728
3.60	2156	1644	1234	3390	1078	3956	2312	2.747
3.70	2174	1649	1229	3403	1087	3965	2316	2.769
3.80	2185	1654	1225	3410	1093	3971	2317	2.784
3.90	2203	1660	1219	3421	1101	3980	2320	2.807
4.00	2213	1663	1216	3430	1107	3986	2323	2.820
4.10	2231	1665	1214	3445	1116	3995	2330	2.838
4.20	2242	1669	1209	3451	1121	3999	2330	2.854
4.30	2253	1670	1208	3461	1126	4005	2334	2.864
4.40	2263	1668	1211	3474	1132	4010	2342	2.870
4.50	2274	1669	1209	3483	1137	4015	2346	2.880
4.60	2285	1672	1206	3490	1142	4021	2348	2.895
4.70	2295	1674	1205	3500	1148	4026	2352	2.905
4.80	2306	1675	1204	3509	1153	4031	2356	2.916
4.90	2316	1677	1201	3518	1158	4036	2359	2.928
5.00	2327	1678	1201	3528	1163	4043	2365	2.937
5.10	2331	1676	1202	3533	1165	4044	2368	2.938
5.20	2341	1674	1205	3546	1171	4049	2375	2.943

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
5.30	2352	1677	1201	3553	1176	4054	2377	2.958
5.40	2362	1680	1200	3562	1181	4061	2381	2.968
5.50	2372	1678	1200	3572	1186	4065	2386	2.977
5.60	2389	1678	1200	3590	1195	4073	2395	2.991
5.70	2400	1677	1201	3601	1200	4078	2401	2.998
5.80	2410	1677	1201	3611	1205	4083	2406	3.007
5.90	2420	1674	1205	3625	1210	4089	2415	3.009
6.00	2437	1669	1209	3647	1219	4097	2428	3.015
6.10	2448	1664	1214	3662	1224	4102	2438	3.016
6.20	2458	1669	1209	3667	1229	4107	2438	3.032
6.30	2468	1669	1209	3677	1234	4112	2443	3.041
6.40	2478	1669	1209	3688	1239	4117	2448	3.049
6.50	2495	1668	1212	3707	1247	4127	2459	3.059
6.60	2492	1668	1212	3703	1246	4125	2458	3.056
6.70	2502	1661	1218	3719	1251	4129	2468	3.055
6.80	2505	1656	1221	3726	1253	4130	2474	3.052
6.90	2515	1654	1225	3740	1258	4136	2482	3.054
7.00	2525	1656	1222	3748	1263	4141	2485	3.066
7.10	2529	1655	1223	3752	1264	4143	2488	3.067
7.20	2538	1654	1226	3764	1269	4149	2495	3.071
7.30	2548	1654	1225	3773	1274	4153	2499	3.081
7.40	2552	1650	1228	3780	1276	4154	2504	3.078
7.50	2562	1649	1230	3792	1281	4160	2511	3.082
7.60	2572	1642	1236	3808	1286	4164	2522	3.080
7.70	2581	1637	1241	3822	1291	4169	2532	3.080
7.80	2585	1634	1245	3829	1292	4171	2537	3.077
7.90	2594	1636	1243	3838	1297	4177	2541	3.087
8.00	2598	1637	1241	3839	1299	4177	2540	3.093
8.10	2607	1635	1245	3852	1304	4183	2548	3.095
8.20	2617	1634	1246	3863	1309	4188	2554	3.101
8.30	2620	1630	1248	3868	1310	4188	2558	3.100
8.40	2630	1628	1250	3880	1315	4193	2565	3.103
8.50	2633	1626	1253	3886	1317	4195	2569	3.102
8.60	2636	1623	1256	3892	1318	4198	2574	3.098
8.70	2646	1621	1259	3904	1323	4202	2581	3.102
8.80	2649	1613	1266	3914	1324	4203	2590	3.093
8.90	2652	1608	1270	3922	1326	4204	2596	3.088
9.00	2655	1605	1274	3929	1327	4206	2601	3.084
9.10	2658	1606	1274	3932	1329	4208	2603	3.087
9.20	2654	1605	1274	3928	1327	4206	2601	3.084
9.30	2664	1603	1275	3939	1332	4210	2607	3.089
9.40	2661	1602	1276	3937	1330	4209	2606	3.085
9.50	2663	1600	1279	3942	1332	4210	2610	3.083
9.60	2673	1598	1282	3955	1336	4216	2618	3.085
9.70	2676	1595	1283	3959	1338	4216	2621	3.085
9.80	2685	1592	1287	3972	1343	4221	2629	3.087
9.90	2682	1588	1290	3972	1341	4219	2631	3.079
10.00	2697	1583	1295	3992	1349	4227	2644	3.083
10.10	2700	1578	1301	4001	1350	4229	2651	3.076
10.20	2710	1571	1308	4017	1355	4233	2663	3.072
10.30	2719	1572	1307	4025	1359	4238	2666	3.081
10.40	2715	1571	1309	4024	1358	4237	2667	3.074
10.50	2725	1569	1309	4033	1362	4241	2671	3.082
10.60	2727	1567	1311	4039	1364	4242	2675	3.080
10.70	2736	1565	1314	4050	1368	4247	2682	3.083
10.80	2746	1571	1309	4054	1373	4252	2682	3.098
10.90	2748	1562	1316	4064	1374	4253	2690	3.089
11.00	2751	1558	1321	4072	1376	4254	2696	3.083
11.10	2754	1553	1325	4079	1377	4255	2702	3.078
11.20	2750	1545	1334	4084	1375	4253	2709	3.062
11.30	2766	1538	1341	4106	1383	4261	2723	3.063
11.40	2768	1541	1337	4105	1384	4262	2721	3.070
11.50	2771	1540	1339	4110	1385	4265	2725	3.069
11.60	2774	1538	1341	4114	1387	4265	2727	3.069

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
11.70	2776	1537	1342	4118	1388	4266	2730	3.069
11.80	2779	1533	1346	4125	1389	4269	2736	3.064
11.90	2782	1531	1348	4129	1391	4269	2738	3.064
12.00	2784	1528	1350	4134	1392	4270	2742	3.062
12.10	2787	1525	1353	4140	1393	4272	2747	3.059
12.20	2789	1523	1356	4145	1395	4273	2750	3.057
12.30	2792	1519	1359	4151	1396	4274	2755	3.054
12.40	2801	1517	1362	4162	1400	4279	2762	3.057
12.50	2797	1509	1370	4167	1399	4277	2768	3.042
12.60	2806	1504	1375	4180	1403	4281	2777	3.041
12.70	2808	1500	1378	4186	1404	4282	2782	3.038
12.80	2817	1502	1377	4194	1409	4287	2785	3.046
12.90	2813	1502	1377	4190	1407	4285	2783	3.043
13.00	2822	1500	1378	4200	1411	4289	2789	3.048
13.10	2824	1499	1380	4205	1412	4292	2793	3.046
13.20	2833	1498	1380	4213	1416	4295	2797	3.052
13.30	2835	1496	1384	4219	1418	4297	2802	3.049
13.40	2838	1493	1385	4223	1419	4297	2804	3.049
13.50	2840	1491	1387	4228	1420	4298	2807	3.047
13.60	2843	1489	1390	4232	1421	4300	2811	3.045
13.70	2845	1485	1394	4239	1422	4302	2817	3.040
13.80	2847	1483	1396	4243	1424	4302	2819	3.040
13.90	2850	1479	1399	4249	1425	4303	2824	3.037
14.00	2852	1477	1400	4252	1426	4303	2826	3.037
14.10	2848	1473	1405	4253	1424	4302	2829	3.027
14.20	2856	1470	1409	4265	1428	4307	2837	3.028
14.30	2853	1462	1417	4269	1426	4305	2843	3.014
14.40	2855	1457	1420	4275	1428	4305	2848	3.010
14.50	2857	1455	1424	4281	1429	4307	2852	3.007
14.60	2859	1456	1423	4282	1430	4308	2852	3.010
14.70	2862	1457	1421	4283	1431	4309	2852	3.013
14.80	2870	1456	1424	4294	1435	4315	2859	3.016
14.90	2872	1455	1424	4296	1436	4314	2860	3.017
15.00	2880	1452	1426	4306	1440	4319	2866	3.020
15.10	2883	1451	1427	4310	1441	4320	2869	3.020
15.20	2885	1449	1431	4315	1442	4322	2873	3.016
15.30	2893	1446	1432	4325	1447	4325	2878	3.020
15.40	2895	1449	1430	4325	1448	4326	2877	3.025
15.50	2897	1444	1434	4331	1449	4327	2883	3.020
15.60	2905	1439	1439	4344	1453	4331	2892	3.019
15.70	2907	1437	1442	4350	1454	4333	2896	3.016
15.80	2909	1434	1445	4354	1455	4333	2900	3.014
15.90	2912	1430	1448	4360	1456	4334	2904	3.010
16.00	2914	1428	1451	4364	1457	4335	2907	3.008
16.10	2922	1425	1453	4375	1461	4339	2914	3.011
16.20	2918	1422	1457	4374	1459	4337	2915	3.003
16.30	2926	1420	1459	4384	1463	4341	2922	3.005
16.40	2927	1417	1461	4389	1464	4342	2925	3.004
16.50	2924	1414	1465	4388	1462	4340	2927	2.996
16.60	2926	1410	1468	4394	1463	4341	2931	2.993
16.70	2922	1407	1472	4393	1461	4339	2933	2.985
16.80	2924	1405	1473	4396	1462	4340	2935	2.985
16.90	2931	1402	1476	4408	1466	4344	2942	2.985
17.00	2933	1401	1478	4411	1467	4345	2944	2.985
17.10	2941	1398	1480	4421	1471	4349	2950	2.987
17.20	2943	1395	1483	4426	1472	4350	2955	2.984
17.30	2945	1393	1486	4431	1472	4351	2958	2.982
17.40	2947	1390	1488	4435	1473	4352	2961	2.980
17.50	2948	1388	1490	4439	1474	4353	2965	2.978
17.60	2950	1387	1493	4443	1475	4355	2968	2.976
17.70	2958	1384	1494	4452	1479	4357	2973	2.980
17.80	2966	1382	1496	4462	1483	4361	2979	2.982
17.90	2962	1381	1498	4459	1481	4359	2978	2.978
18.00	2963	1380	1500	4463	1482	4361	2981	2.976

Project Name: Taylor Geo-Engineering
Project Number: M00991-001
Sample: CH-5-98
Comments: Samples were compacted to 90% of ASTM D698 at
Test Number: S2

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Axial strain, ε (%)	σ_d ($\sigma_1-\sigma_3$) (psf)	Δ pore press., Δu (psf)	Effective σ'_3 (psf)	Effective σ'_1 (psf)	q ($\sigma_1-\sigma_3$)/2 (psf)	p ($\sigma_1+\sigma_3$)/2 (psf)	p' ($\sigma'_1+\sigma'_3$)/2 (psf)	σ'_1/σ'_3
0.00	-29	0	5754	5725	-14	5740	5740	1.005
0.02	325	76	5678	6002	162	5916	5840	1.057
0.04	533	160	5593	6127	267	6021	5860	1.095
0.06	677	227	5527	6204	339	6093	5865	1.123
0.08	785	288	5466	6251	393	6146	5858	1.144
0.10	893	348	5406	6299	446	6200	5852	1.165
0.20	1265	600	5155	6421	633	6388	5788	1.245
0.30	1537	805	4949	6486	768	6522	5718	1.311
0.40	1757	990	4764	6522	879	6633	5643	1.369
0.50	1949	1156	4598	6547	974	6728	5572	1.424
0.60	2118	1301	4453	6571	1059	6813	5512	1.476
0.70	2259	1428	4327	6586	1129	6884	5457	1.522
0.80	2399	1546	4208	6607	1200	6954	5408	1.570
0.90	2525	1653	4101	6626	1262	7016	5364	1.616
1.00	2650	1757	3997	6647	1325	7079	5322	1.663
1.10	2761	1846	3908	6669	1381	7135	5289	1.707
1.20	2858	1927	3827	6685	1429	7183	5256	1.747
1.30	2954	2003	3752	6706	1477	7232	5229	1.787
1.40	3050	2079	3675	6725	1525	7279	5200	1.830
1.50	3117	2140	3614	6731	1559	7312	5173	1.862
1.60	3199	2196	3558	6757	1599	7353	5157	1.899
1.70	3266	2248	3508	6773	1633	7388	5140	1.931
1.80	3340	2298	3456	6796	1670	7424	5126	1.966
1.90	3399	2344	3412	6811	1700	7455	5111	1.996
2.00	3452	2386	3369	6821	1726	7481	5095	2.024
2.10	3512	2423	3331	6842	1756	7510	5087	2.054
2.20	3564	2457	3297	6861	1782	7536	5079	2.081
2.30	3616	2491	3263	6879	1808	7562	5071	2.108
2.40	3661	2523	3231	6892	1831	7584	5062	2.133
2.50	3713	2553	3201	6914	1857	7610	5057	2.160
2.60	3758	2581	3174	6931	1879	7634	5053	2.184
2.70	3796	2606	3148	6944	1898	7652	5046	2.206
2.80	3833	2629	3125	6958	1917	7671	5041	2.227
2.90	3878	2650	3105	6982	1939	7694	5044	2.249
3.00	3908	2673	3081	6990	1954	7708	5035	2.268
3.10	3953	2695	3059	7012	1976	7730	5035	2.292
3.20	3983	2714	3040	7023	1991	7745	5032	2.310
3.30	4020	2731	3023	7043	2010	7764	5033	2.330
3.40	4050	2748	3008	7058	2025	7780	5033	2.347
3.50	4080	2763	2992	7072	2040	7795	5032	2.364
3.60	4110	2779	2975	7085	2055	7809	5030	2.382
3.70	4140	2793	2962	7102	2070	7825	5032	2.398
3.80	4163	2806	2949	7112	2082	7837	5030	2.412
3.90	4193	2818	2936	7129	2097	7850	5033	2.428
4.00	4216	2828	2926	7141	2108	7862	5033	2.441
4.10	4239	2839	2915	7154	2119	7873	5034	2.454
4.20	4268	2850	2906	7174	2134	7889	5040	2.469
4.30	4291	2858	2896	7187	2145	7899	5042	2.482
4.40	4313	2867	2888	7201	2157	7912	5045	2.494
4.50	4336	2875	2879	7215	2168	7922	5047	2.506
4.60	4365	2882	2872	7237	2183	7937	5054	2.520
4.70	4388	2889	2865	7252	2194	7948	5058	2.532
4.80	4403	2898	2858	7261	2202	7957	5059	2.541
4.90	4432	2905	2849	7282	2216	7970	5066	2.556
5.00	4448	2908	2846	7294	2224	7978	5070	2.563
5.10	4463	2913	2841	7304	2232	7985	5073	2.571
5.20	4485	2916	2838	7323	2243	7997	5080	2.581

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
11.70	5172	2840	2914	8086	2586	8340	5500	2.775
11.80	5172	2838	2916	8089	2586	8340	5502	2.774
11.90	5179	2834	2920	8098	2589	8343	5509	2.774
12.00	5185	2832	2922	8107	2593	8346	5515	2.775
12.10	5191	2828	2927	8118	2596	8351	5522	2.774
12.20	5191	2825	2929	8120	2596	8350	5525	2.772
12.30	5198	2821	2934	8131	2599	8354	5533	2.772
12.40	5204	2818	2937	8141	2602	8357	5539	2.772
12.50	5210	2816	2940	8150	2605	8360	5545	2.772
12.60	5216	2812	2942	8158	2608	8362	5550	2.773
12.70	5223	2809	2945	8168	2611	8365	5557	2.773
12.80	5222	2805	2949	8171	2611	8365	5560	2.771
12.90	5235	2802	2952	8187	2617	8371	5570	2.773
13.00	5241	2798	2957	8198	2620	8375	5577	2.772
13.10	5241	2794	2959	8200	2620	8374	5580	2.771
13.20	5246	2791	2964	8211	2623	8378	5587	2.770
13.30	5246	2787	2967	8213	2623	8377	5590	2.769
13.40	5252	2784	2970	8222	2626	8380	5596	2.768
13.50	5258	2782	2972	8231	2629	8383	5602	2.769
13.60	5264	2776	2978	8242	2632	8386	5610	2.768
13.70	5270	2773	2981	8251	2635	8389	5616	2.768
13.80	5276	2771	2983	8259	2638	8392	5621	2.769
13.90	5276	2768	2986	8262	2638	8392	5624	2.767
14.00	5275	2764	2990	8265	2638	8392	5628	2.764
14.10	5287	2759	2995	8282	2644	8398	5638	2.766
14.20	5293	2757	2998	8291	2646	8402	5645	2.765
14.30	5299	2752	3002	8300	2649	8403	5651	2.765
14.40	5298	2750	3005	8303	2649	8404	5654	2.763
14.50	5304	2746	3009	8313	2652	8407	5661	2.763
14.60	5310	2743	3011	8321	2655	8409	5666	2.763
14.70	5309	2739	3015	8324	2655	8409	5669	2.761
14.80	5315	2736	3019	8334	2657	8412	5677	2.760
14.90	5314	2731	3023	8337	2657	8411	5680	2.758
15.00	5320	2723	3030	8350	2660	8413	5690	2.756
15.10	5319	2715	3038	8357	2660	8412	5698	2.751
15.20	5331	2714	3040	8371	2665	8419	5706	2.753
15.30	5336	2715	3039	8375	2668	8422	5707	2.756
15.40	5348	2715	3039	8387	2674	8428	5713	2.760
15.50	5341	2715	3040	8381	2670	8426	5711	2.757
15.60	5346	2713	3041	8388	2673	8427	5715	2.758
15.70	5352	2711	3044	8396	2676	8431	5720	2.758
15.80	5357	2710	3044	8401	2679	8433	5722	2.760
15.90	5356	2708	3046	8403	2678	8432	5724	2.758
16.00	5362	2707	3047	8409	2681	8435	5728	2.760
16.10	5361	2704	3050	8411	2681	8434	5730	2.758
16.20	5366	2702	3053	8419	2683	8438	5736	2.758
16.30	5371	2698	3056	8427	2686	8440	5741	2.758
16.40	5377	2696	3058	8435	2688	8442	5746	2.758
16.50	5376	2694	3061	8437	2688	8443	5749	2.756
16.60	5381	2689	3065	8446	2690	8444	5755	2.756
16.70	5386	2686	3068	8454	2693	8447	5761	2.755
16.80	5385	2682	3072	8457	2693	8447	5765	2.753
16.90	5390	2677	3078	8468	2695	8450	5773	2.751
17.00	5389	2674	3080	8469	2695	8449	5775	2.750
17.10	5394	2669	3085	8479	2697	8451	5782	2.749
17.20	5393	2664	3089	8483	2697	8451	5786	2.746
17.30	5392	2660	3094	8487	2696	8450	5790	2.743
17.40	5397	2656	3099	8496	2699	8454	5797	2.742
17.50	5402	2653	3101	8503	2701	8455	5802	2.742
17.60	5395	2643	3111	8506	2698	8452	5808	2.735
17.70	5400	2632	3122	8522	2700	8454	5822	2.730
17.80	5405	2627	3127	8532	2703	8456	5829	2.729
17.90	5404	2632	3123	8527	2702	8457	5825	2.730
18.00	5403	2632	3122	8525	2701	8455	5824	2.730

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
18.10	5408	2632	3122	8530	2704	8458	5826	2.732
18.20	5406	2629	3125	8531	2703	8457	5828	2.730
18.30	5411	2628	3126	8537	2706	8459	5831	2.731
18.40	5404	2625	3129	8533	2702	8456	5831	2.727
18.50	5409	2622	3133	8542	2704	8459	5837	2.726
18.60	5408	2620	3134	8542	2704	8458	5838	2.726
18.70	5412	2618	3136	8549	2706	8460	5842	2.726
18.80	5411	2615	3139	8550	2706	8459	5844	2.724
18.90	5416	2611	3145	8560	2708	8463	5852	2.722
19.00	5420	2607	3148	8568	2710	8465	5858	2.722
19.10	5419	2604	3152	8570	2709	8464	5861	2.719
19.20	5423	2599	3155	8579	2712	8466	5867	2.719
19.30	5428	2594	3160	8588	2714	8468	5874	2.718
19.40	5421	2591	3163	8584	2710	8464	5874	2.714
19.50	5431	2586	3168	8599	2716	8470	5884	2.714
19.60	5424	2580	3174	8598	2712	8466	5886	2.709
19.70	5423	2570	3184	8607	2711	8465	5896	2.703
19.80	5433	2561	3193	8625	2716	8470	5909	2.702
19.90	5431	2564	3190	8622	2716	8470	5906	2.703
20.00	5436	2564	3190	8626	2718	8472	5908	2.704

Project Name: Taylor Geo-Engineering
Project Number: M00991-001
Sample: CH-5-98
Comments: Samples were compacted to 90% of ASTM D698 at
Test Number: S3

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Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
0.00	-10	0	11522	11512	-5	11517	11517	1.001
0.02	46	18	11506	11552	23	11547	11529	1.004
0.04	46	30	11493	11539	23	11546	11516	1.004
0.06	54	43	11480	11534	27	11550	11507	1.005
0.08	54	55	11468	11522	27	11550	11495	1.005
0.10	46	67	11457	11502	23	11546	11479	1.004
0.20	45	126	11397	11442	23	11545	11419	1.004
0.30	44	178	11347	11391	22	11547	11369	1.004
0.40	44	224	11300	11343	22	11546	11322	1.004
0.50	51	269	11255	11306	26	11550	11281	1.005
0.60	51	315	11208	11259	25	11549	11234	1.005
0.70	42	357	11166	11208	21	11544	11187	1.004
0.80	41	396	11128	11169	21	11544	11148	1.004
0.90	41	432	11091	11132	20	11543	11111	1.004
1.00	40	470	11054	11094	20	11544	11074	1.004
1.10	39	507	11016	11056	20	11543	11036	1.004
1.20	39	547	10976	11015	19	11543	10996	1.004
1.30	30	587	10937	10967	15	11539	10952	1.003
1.40	29	623	10900	10930	15	11538	10915	1.003
1.50	29	657	10866	10895	14	11538	10881	1.003
1.60	28	691	10832	10861	14	11537	10846	1.003
1.70	27	727	10797	10825	14	11538	10811	1.003
1.80	19	760	10763	10782	10	11533	10773	1.002
1.90	18	792	10733	10751	9	11534	10742	1.002
2.00	18	822	10701	10719	9	11532	10710	1.002
2.10	17	853	10671	10688	9	11532	10679	1.002
2.20	9	883	10640	10649	4	11528	10645	1.001
2.30	16	911	10612	10628	8	11531	10620	1.002
2.40	7	936	10588	10595	4	11527	10591	1.001
2.50	7	967	10556	10563	3	11526	10559	1.001
2.60	6	998	10526	10532	3	11527	10529	1.001
2.70	6	1024	10500	10505	3	11527	10503	1.001
2.80	5	1052	10473	10478	3	11527	10475	1.000
2.90	-3	1078	10446	10443	-2	11522	10444	1.000
3.00	4	1104	10420	10424	2	11526	10422	1.000
3.10	-4	1129	10394	10390	-2	11521	10392	1.000
3.20	-5	1151	10372	10367	-3	11521	10370	1.000
3.30	-6	1176	10347	10342	-3	11521	10345	1.001
3.40	-14	1201	10323	10309	-7	11517	10316	1.001
3.50	-7	1218	10307	10300	-3	11521	10303	1.001
3.60	-7	1240	10283	10276	-4	11519	10279	1.001
3.70	1476	1410	10113	11589	738	12261	10851	1.146
3.80	2203	1545	9979	12182	1102	12625	11080	1.221
3.90	2681	1650	9873	12554	1340	12864	11214	1.272
4.00	3072	1759	9764	12837	1536	13059	11300	1.315
4.10	3401	1884	9639	13040	1701	13224	11340	1.353
4.20	3675	1993	9530	13205	1838	13361	11368	1.386
4.30	3918	2118	9406	13324	1959	13483	11365	1.417
4.40	4145	2245	9278	13423	2072	13596	11351	1.447
4.50	4355	2372	9152	13507	2178	13701	11329	1.476
4.60	4527	2489	9035	13562	2264	13787	11298	1.501
4.70	4691	2605	8919	13610	2346	13869	11264	1.526
4.80	4847	2717	8806	13653	2423	13947	11230	1.550
4.90	4987	2821	8702	13689	2494	14016	11195	1.573
5.00	5111	2921	8602	13714	2556	14079	11158	1.594
5.10	5236	3018	8505	13741	2618	14141	11123	1.616
5.20	5344	3114	8409	13753	2672	14195	11081	1.636

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
5.30	5453	3204	8320	13773	2726	14250	11046	1.655
5.40	5546	3306	8217	13763	2773	14296	10990	1.675
5.50	5638	3400	8123	13762	2819	14343	10943	1.694
5.60	5731	3489	8034	13765	2865	14389	10900	1.713
5.70	5800	3579	7944	13744	2900	14423	10844	1.730
5.80	5885	3664	7860	13744	2942	14466	10802	1.749
5.90	5954	3744	7779	13733	2977	14500	10756	1.765
6.00	6023	3818	7705	13728	3011	14535	10717	1.782
6.10	6084	3894	7629	13713	3042	14565	10671	1.797
6.20	6145	3968	7555	13700	3072	14596	10628	1.813
6.30	6198	4038	7485	13683	3099	14622	10584	1.828
6.40	6251	4105	7418	13670	3126	14649	10544	1.843
6.50	6304	4174	7349	13654	3152	14675	10501	1.858
6.60	6357	4242	7281	13639	3179	14702	10460	1.873
6.70	6395	4305	7218	13613	3198	14721	10416	1.886
6.80	6425	4365	7158	13584	3213	14736	10371	1.898
6.90	6470	4428	7095	13566	3235	14758	10330	1.912
7.00	6508	4490	7033	13541	3254	14777	10287	1.925
7.10	6553	4548	6976	13529	3276	14800	10252	1.939
7.20	6590	4603	6921	13511	3295	14819	10216	1.952
7.30	6620	4658	6867	13487	3310	14835	10177	1.964
7.40	6649	4709	6815	13465	3325	14849	10140	1.976
7.50	6679	4759	6765	13444	3340	14863	10104	1.987
7.60	6716	4801	6723	13439	3358	14882	10081	1.999
7.70	6753	4849	6675	13428	3377	14900	10051	2.012
7.80	6782	4897	6627	13409	3391	14915	10018	2.023
7.90	6811	4951	6573	13384	3406	14929	9979	2.036
8.00	6833	4997	6526	13359	3417	14940	9943	2.047
8.10	6877	5042	6483	13360	3439	14963	9921	2.061
8.20	6906	5086	6437	13343	3453	14976	9890	2.073
8.30	6928	5126	6397	13325	3464	14987	9861	2.083
8.40	6964	5167	6356	13320	3482	15005	9838	2.096
8.50	6993	5206	6319	13311	3496	15021	9815	2.107
8.60	7014	5242	6281	13295	3507	15030	9788	2.117
8.70	7042	5280	6244	13286	3521	15045	9765	2.128
8.80	7064	5317	6206	13270	3532	15055	9738	2.138
8.90	7092	5345	6178	13270	3546	15069	9724	2.148
9.00	7113	5377	6147	13260	3557	15080	9703	2.157
9.10	7141	5414	6109	13250	3571	15094	9680	2.169
9.20	7162	5444	6080	13242	3581	15105	9661	2.178
9.30	7183	5475	6048	13231	3592	15115	9640	2.188
9.40	7204	5508	6015	13219	3602	15125	9617	2.198
9.50	7225	5542	5981	13206	3612	15136	9594	2.208
9.60	7253	5575	5949	13201	3626	15150	9575	2.219
9.70	7266	5601	5923	13189	3633	15156	9556	2.227
9.80	7286	5636	5888	13174	3643	15167	9531	2.238
9.90	7307	5667	5856	13163	3653	15177	9509	2.248
10.00	7313	5698	5826	13138	3656	15180	9482	2.255
10.10	7340	5731	5794	13134	3670	15195	9464	2.267
10.20	7361	5763	5760	13120	3680	15204	9440	2.278
10.30	7373	5794	5730	13103	3687	15210	9416	2.287
10.40	7394	5820	5704	13097	3697	15220	9401	2.296
10.50	7407	5849	5675	13081	3703	15227	9378	2.305
10.60	7419	5876	5648	13067	3710	15233	9357	2.314
10.70	7432	5903	5621	13053	3716	15239	9337	2.322
10.80	7438	5926	5597	13035	3719	15242	9316	2.329
10.90	7457	5951	5573	13030	3729	15252	9301	2.338
11.00	7470	5974	5550	13020	3735	15260	9285	2.346
11.10	7475	5995	5528	13004	3738	15261	9266	2.352
11.20	7495	6016	5507	13002	3748	15271	9255	2.361
11.30	7501	6037	5486	12986	3750	15274	9236	2.367
11.40	7506	6053	5471	12977	3753	15276	9224	2.372
11.50	7518	6070	5453	12971	3759	15283	9212	2.379
11.60	7523	6086	5438	12961	3762	15285	9200	2.384

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
11.70	7536	6107	5417	12953	3768	15291	9185	2.391
11.80	7534	6126	5397	12931	3767	15290	9164	2.396
11.90	7539	6145	5378	12917	3770	15293	9148	2.402
12.00	7551	6164	5359	12911	3776	15299	9135	2.409
12.10	7556	6186	5337	12893	3778	15302	9115	2.416
12.20	7568	6207	5317	12886	3784	15309	9101	2.423
12.30	7580	6230	5294	12874	3790	15314	9084	2.432
12.40	7585	6251	5273	12858	3793	15316	9066	2.439
12.50	7590	6268	5255	12846	3795	15319	9050	2.444
12.60	7609	6287	5237	12846	3805	15328	9041	2.453
12.70	7621	6306	5218	12839	3811	15334	9028	2.461
12.80	7626	6323	5200	12826	3813	15336	9013	2.466
12.90	7645	6341	5183	12827	3822	15346	9005	2.475
13.00	7657	6355	5169	12825	3828	15352	8997	2.481
13.10	7668	6369	5155	12823	3834	15358	8989	2.488
13.20	7687	6382	5142	12829	3844	15367	8985	2.495
13.30	7699	6395	5129	12827	3849	15373	8978	2.501
13.40	7710	6405	5118	12828	3855	15378	8973	2.506
13.50	7722	6416	5108	12829	3861	15384	8968	2.512
13.60	7733	6423	5101	12834	3867	15390	8967	2.516
13.70	7744	6431	5092	12837	3872	15396	8965	2.521
13.80	7749	6438	5085	12834	3875	15398	8960	2.524
13.90	7760	6447	5076	12836	3880	15403	8956	2.529
14.00	7778	6456	5068	12846	3889	15413	8957	2.535
14.10	7783	6465	5058	12841	3891	15415	8950	2.539
14.20	7787	6473	5050	12837	3894	15417	8944	2.542
14.30	7798	6499	5025	12823	3899	15423	8924	2.552
14.40	7802	6514	5010	12813	3901	15426	8912	2.557
14.50	7813	6516	5007	12820	3907	15430	8914	2.561
14.60	7824	6516	5007	12831	3912	15436	8919	2.563
14.70	7829	6518	5006	12834	3914	15438	8920	2.564
14.80	7833	6525	4999	12831	3916	15440	8915	2.567
14.90	7843	6529	4995	12839	3922	15446	8917	2.570
15.00	7847	6536	4987	12834	3924	15447	8911	2.574
15.10	7858	6543	4980	12838	3929	15453	8909	2.578
15.20	7855	6549	4974	12829	3928	15451	8902	2.579
15.30	7873	6556	4967	12840	3936	15460	8904	2.585
15.40	7877	6563	4960	12837	3938	15462	8898	2.588
15.50	7880	6569	4954	12835	3940	15464	8894	2.591
15.60	7884	6560	4964	12848	3942	15466	8906	2.588
15.70	7895	6567	4957	12851	3947	15471	8904	2.593
15.80	7892	6573	4951	12842	3946	15469	8897	2.594
15.90	7895	6574	4950	12845	3948	15471	8897	2.595
16.00	7899	6586	4938	12837	3950	15473	8887	2.600
16.10	7909	6597	4926	12836	3955	15478	8881	2.606
16.20	7906	6606	4918	12824	3953	15477	8871	2.608
16.30	7917	6610	4913	12830	3958	15482	8872	2.611
16.40	7920	6616	4907	12828	3960	15484	8868	2.614
16.50	7924	6622	4902	12825	3962	15485	8863	2.617
16.60	7920	6627	4897	12817	3960	15484	8857	2.617
16.70	7924	6631	4892	12816	3962	15485	8854	2.620
16.80	7927	6638	4885	12812	3964	15487	8849	2.623
16.90	7931	6641	4883	12813	3965	15489	8848	2.624
17.00	7934	6645	4878	12812	3967	15490	8845	2.626
17.10	7944	6652	4871	12815	3972	15495	8843	2.631
17.20	7947	6661	4863	12810	3974	15497	8836	2.634
17.30	7950	6668	4856	12806	3975	15499	8831	2.637
17.40	7960	6670	4854	12814	3980	15504	8834	2.640
17.50	7977	6676	4848	12824	3988	15512	8836	2.645
17.60	7973	6677	4848	12821	3987	15511	8834	2.645
17.70	7976	6679	4844	12820	3988	15512	8832	2.647
17.80	7979	6680	4843	12822	3990	15513	8833	2.648
17.90	7989	6678	4845	12834	3995	15518	8840	2.649
18.00	7999	6677	4847	12845	3999	15523	8846	2.650

Isotropically Consolidated Undrained with Pore Pressure (CIU/PP)

IGES

Project Name: Taylor Geo-Engineering
Project Number: M00991-001
Sample: SP-16-13
Comments: Samples were compacted to 90% of ASTM D698 at OMC.

	Test Number	S1	S2	S3	
Initial	Height, H (in)	5.87	5.82	5.66	
	Diameter, D (in)	2.42	2.42	2.42	
	Moisture Content, w (%)	16.9	16.9	16.9	
	Dry Unit Weight, γd (pcf)	99.9	99.8	99.8	
	Saturation (%)	66.4	66.3	66.2	
	Void Ratio, e	0.69	0.69	0.69	
Before Shear	Moisture Content, w (%)	20.6	19.3	19.0	
	Dry Unit Weight, γd (pcf)	107.1	109.5	110.0	
	Saturation (%)	100.0	100.0	100.0	
	Void Ratio, e	0.56	0.52	0.51	
	B	0.96	0.95	0.96	
	Back pressure (psf)	7343.3	8207.6	4751.5	
	Strain rate (%/min)	0.033	0.033	0.033	
	Time to Failure (min)	606.1	606.1	606.1	
Total Stress	Strain at Failure, εf (%)	20.00	20.00	20.00	
	σ3 (psf)	2880	5759	11524	
	σ1-σ3 (psf)	2443	4466	8909	
	σ1 (psf)	5323	10225	20432	
	q = (σ1-σ3)/2 (psf)	1222	2233	4454	
	p = (σ1+σ3)/2 (psf)	4101	7992	15978	
Effective Stress	u (psf)	1783	3649	7116	
	σ'3 (psf)	1097	2109	4407	
	σ'1-σ'3 (psf)	2443	4466	8909	
	σ'1 (psf)	3541	6576	13316	
	q = (σ'1-σ'3)/2 (psf)	1222	2233	4454	
	p' = (σ'1+σ'3)/2 (psf)	2319	4343	8862	
	σ'1/σ'3	3.23	3.12	3.02	
	A = u/(σ1−σ3)	0.730	0.817	0.799	

Estimated Specific Gravity	2.70
Plastic Limit (%)	16
Liquid Limit (%)	31
Plasticity Index (%)	15

Summary of Strength Paramaters	Total Stress	Effective Stress
c (psf)	84	94
ϕ (deg)	15.9	29.6
tan ϕ	0.284	0.568

[a] Saturation set to 100% for phase calculations

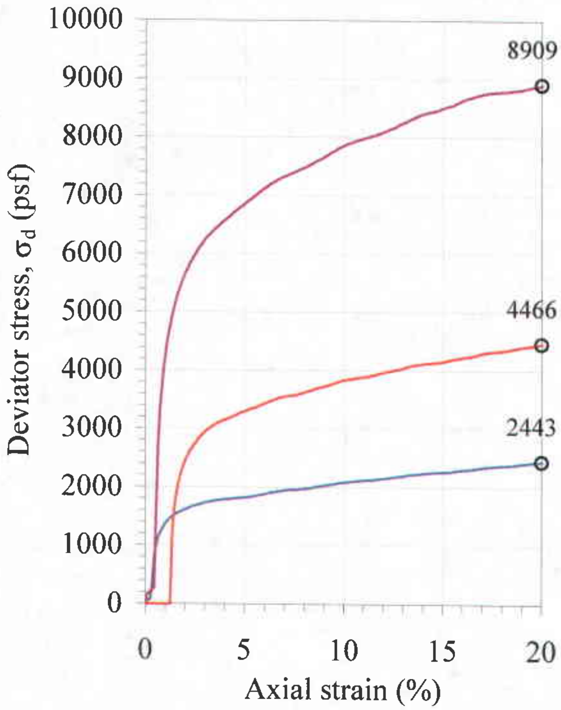
Tested by:___________

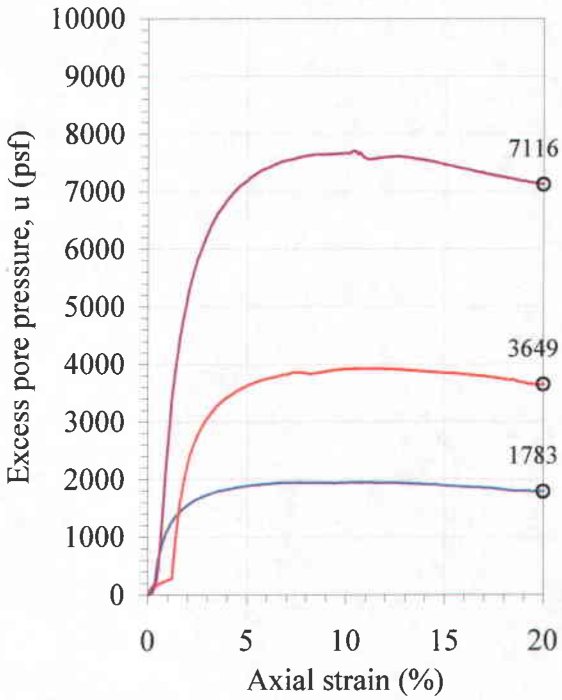
Reviewed:___________

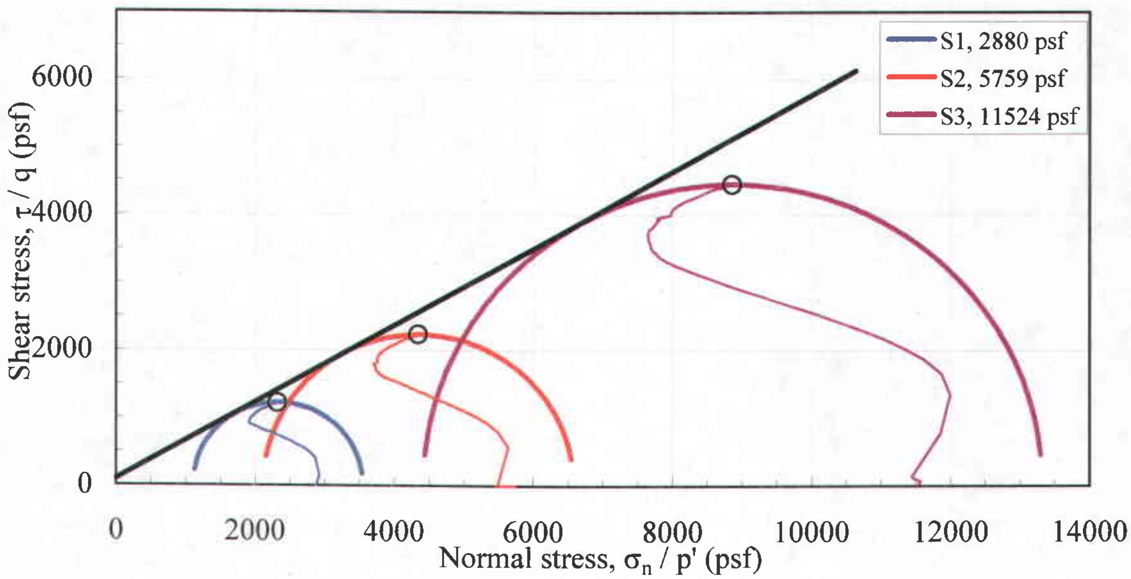
Isotropically Consolidated Undrained with Pore Pressure (CIU/PP)

Project Name: Taylor Geo-Engineering
Project Number: M00991-001
Sample: SP-16-13
Comments:

Summary of Strength Paramaters	Total Stress	Effective Stress
c (psf)	84	94
ϕ (deg)	15.9	29.6
tan ϕ	0.284	0.568







Project Name: Taylor Geo-Engineering
Project Number: M00991-001
Sample: SP-16-13
Comments: Samples were compacted to 90% of ASTM D698 at
Test Number: S1

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Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
0.00	-4	0	2879	2874	-2	2877	2877	1.001
0.02	55	21	2857	2912	27	2906	2885	1.019
0.04	55	23	2855	2910	27	2906	2883	1.019
0.06	59	25	2854	2913	29	2908	2883	1.021
0.08	63	27	2853	2916	32	2911	2884	1.022
0.10	63	28	2850	2913	31	2910	2882	1.022
0.20	71	35	2843	2914	35	2914	2879	1.025
0.30	302	116	2761	3064	151	3028	2913	1.109
0.40	811	424	2455	3265	405	3284	2860	1.330
0.50	1003	618	2260	3263	501	3380	2762	1.444
0.60	1123	768	2110	3233	562	3440	2672	1.532
0.70	1206	891	1987	3193	603	3481	2590	1.607
0.80	1279	994	1884	3164	640	3518	2524	1.679
0.90	1336	1079	1800	3136	668	3547	2468	1.742
1.00	1385	1154	1725	3110	692	3571	2417	1.803
1.10	1425	1217	1661	3085	712	3590	2373	1.858
1.20	1456	1273	1605	3062	728	3607	2334	1.907
1.30	1484	1321	1557	3041	742	3620	2299	1.953
1.40	1507	1366	1513	3020	753	3632	2266	1.996
1.50	1534	1405	1473	3007	767	3645	2240	2.041
1.60	1553	1441	1438	2991	776	3655	2214	2.080
1.70	1571	1473	1405	2977	786	3664	2191	2.118
1.80	1586	1505	1374	2960	793	3672	2167	2.155
1.90	1600	1533	1345	2946	800	3679	2146	2.190
2.00	1615	1559	1320	2935	808	3686	2127	2.224
2.10	1629	1581	1297	2927	815	3693	2112	2.256
2.20	1644	1605	1274	2918	822	3701	2096	2.290
2.30	1658	1624	1255	2914	829	3709	2084	2.321
2.40	1669	1643	1235	2904	834	3713	2070	2.351
2.50	1679	1661	1218	2897	839	3718	2057	2.379
2.60	1693	1677	1201	2895	847	3725	2048	2.409
2.70	1699	1694	1185	2884	850	3728	2035	2.434
2.80	1713	1709	1171	2884	857	3737	2028	2.463
2.90	1724	1722	1157	2881	862	3740	2019	2.490
3.00	1730	1735	1144	2874	865	3743	2009	2.512
3.10	1736	1746	1132	2868	868	3746	2000	2.533
3.20	1742	1758	1121	2862	871	3749	1991	2.554
3.30	1748	1767	1112	2860	874	3753	1986	2.571
3.40	1754	1778	1101	2854	877	3755	1977	2.593
3.50	1759	1787	1091	2851	880	3758	1971	2.612
3.60	1765	1797	1082	2847	883	3761	1965	2.632
3.70	1771	1805	1074	2845	886	3764	1959	2.650
3.80	1773	1813	1067	2840	887	3766	1953	2.662
3.90	1779	1820	1060	2839	889	3769	1949	2.679
4.00	1781	1827	1053	2833	890	3770	1943	2.692
4.10	1783	1834	1044	2827	891	3770	1936	2.707
4.20	1788	1839	1040	2828	894	3773	1934	2.720
4.30	1790	1846	1033	2823	895	3774	1928	2.733
4.40	1796	1852	1027	2823	898	3776	1925	2.749
4.50	1802	1858	1021	2823	901	3779	1922	2.765
4.60	1803	1863	1015	2819	902	3780	1917	2.776
4.70	1805	1868	1012	2817	903	3782	1914	2.784
4.80	1811	1874	1006	2817	905	3785	1911	2.800
4.90	1817	1879	1000	2817	908	3787	1908	2.817
5.00	1818	1882	996	2815	909	3788	1906	2.825
5.10	1824	1887	992	2816	912	3791	1904	2.839
5.20	1830	1893	986	2816	915	3793	1901	2.856

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
5.30	1835	1897	982	2818	918	3797	1900	2.868
5.40	1841	1897	981	2822	921	3799	1902	2.876
5.50	1847	1900	979	2826	923	3802	1902	2.887
5.60	1852	1903	975	2828	926	3805	1902	2.899
5.70	1862	1908	971	2833	931	3810	1902	2.918
5.80	1867	1911	968	2836	934	3813	1902	2.929
5.90	1873	1914	965	2838	937	3815	1901	2.941
6.00	1879	1917	962	2841	939	3819	1902	2.952
6.10	1888	1918	960	2848	944	3823	1904	2.967
6.20	1898	1922	958	2855	949	3828	1907	2.981
6.30	1903	1923	955	2859	952	3830	1907	2.992
6.40	1905	1927	952	2857	952	3831	1904	3.001
6.50	1910	1929	951	2861	955	3835	1906	3.009
6.60	1919	1931	947	2867	960	3838	1907	3.026
6.70	1925	1932	946	2871	962	3841	1909	3.035
6.80	1926	1934	945	2871	963	3842	1908	3.039
6.90	1932	1935	944	2876	966	3844	1910	3.047
7.00	1937	1936	943	2880	969	3847	1911	3.055
7.10	1942	1938	941	2884	971	3851	1913	3.063
7.20	1944	1938	940	2884	972	3851	1912	3.068
7.30	1945	1938	940	2886	973	3851	1913	3.069
7.40	1951	1940	939	2890	975	3854	1914	3.077
7.50	1952	1941	938	2890	976	3855	1914	3.081
7.60	1957	1943	937	2894	979	3858	1915	3.090
7.70	1959	1942	937	2896	979	3858	1916	3.091
7.80	1960	1941	938	2898	980	3859	1918	3.090
7.90	1965	1940	939	2905	983	3861	1922	3.093
8.00	1971	1940	939	2910	985	3864	1924	3.099
8.10	1972	1938	940	2912	986	3865	1926	3.097
8.20	1977	1938	940	2918	989	3867	1929	3.103
8.30	1982	1937	941	2924	991	3870	1933	3.106
8.40	1992	1938	940	2932	996	3874	1936	3.118
8.50	1997	1937	941	2938	998	3877	1940	3.121
8.60	2002	1938	940	2942	1001	3879	1941	3.129
8.70	2011	1937	941	2952	1005	3884	1947	3.136
8.80	2012	1937	941	2954	1006	3885	1947	3.137
8.90	2017	1938	940	2957	1009	3887	1949	3.146
9.00	2022	1938	940	2963	1011	3890	1951	3.151
9.10	2027	1940	940	2968	1014	3893	1954	3.156
9.20	2032	1935	944	2976	1016	3895	1960	3.154
9.30	2038	1932	945	2982	1019	3896	1964	3.156
9.40	2046	1930	947	2994	1023	3901	1970	3.160
9.50	2051	1934	945	2996	1026	3904	1971	3.171
9.60	2056	1936	943	2999	1028	3907	1971	3.182
9.70	2065	1937	941	3007	1033	3911	1974	3.194
9.80	2070	1938	940	3010	1035	3914	1975	3.202
9.90	2071	1940	939	3010	1036	3914	1975	3.206
10.00	2080	1941	938	3018	1040	3918	1978	3.218
10.10	2085	1942	937	3022	1042	3921	1979	3.226
10.20	2090	1943	937	3026	1045	3925	1982	3.231
10.30	2091	1943	936	3026	1045	3924	1981	3.235
10.40	2099	1944	934	3034	1050	3928	1984	3.247
10.50	2100	1944	934	3035	1050	3929	1985	3.248
10.60	2105	1944	936	3041	1053	3932	1988	3.250
10.70	2106	1944	936	3042	1053	3933	1989	3.251
10.80	2111	1944	932	3043	1056	3932	1988	3.265
10.90	2112	1943	936	3048	1056	3935	1992	3.258
11.00	2113	1943	936	3049	1057	3935	1992	3.259
11.10	2118	1943	936	3054	1059	3938	1995	3.264
11.20	2119	1942	937	3056	1060	3938	1996	3.262
11.30	2120	1943	937	3057	1060	3940	1997	3.263
11.40	2125	1942	937	3061	1062	3941	1999	3.268
11.50	2129	1941	938	3067	1065	3943	2003	3.270
11.60	2130	1941	938	3068	1065	3944	2003	3.271

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
11.70	2135	1940	940	3075	1068	3947	2008	3.271
11.80	2140	1938	940	3080	1070	3948	2010	3.276
11.90	2144	1938	940	3085	1072	3951	2012	3.281
12.00	2149	1937	941	3090	1074	3953	2016	3.283
12.10	2153	1937	943	3096	1077	3956	2019	3.285
12.20	2158	1936	943	3101	1079	3958	2022	3.290
12.30	2163	1935	944	3106	1081	3960	2025	3.292
12.40	2167	1934	945	3112	1084	3962	2029	3.294
12.50	2172	1932	946	3118	1086	3964	2032	3.296
12.60	2176	1932	946	3122	1088	3967	2034	3.300
12.70	2181	1932	947	3128	1090	3970	2038	3.302
12.80	2182	1929	950	3131	1091	3969	2040	3.297
12.90	2186	1929	950	3136	1093	3972	2043	3.302
13.00	2194	1928	951	3145	1097	3976	2048	3.308
13.10	2199	1925	953	3152	1099	3978	2053	3.307
13.20	2207	1925	954	3161	1103	3983	2058	3.313
13.30	2211	1923	955	3167	1106	3984	2061	3.314
13.40	2216	1922	957	3172	1108	3986	2064	3.316
13.50	2220	1920	959	3179	1110	3989	2069	3.315
13.60	2224	1918	960	3185	1112	3991	2072	3.317
13.70	2229	1917	961	3190	1114	3993	2076	3.318
13.80	2233	1915	964	3197	1117	3995	2080	3.317
13.90	2237	1914	965	3202	1119	3997	2084	3.319
14.00	2242	1911	967	3209	1121	3999	2088	3.318
14.10	2242	1910	968	3211	1121	4000	2090	3.316
14.20	2247	1909	969	3216	1123	4002	2093	3.317
14.30	2247	1907	973	3220	1124	4003	2097	3.310
14.40	2251	1911	968	3220	1126	4006	2094	3.325
14.50	2252	1909	969	3222	1126	4005	2096	3.323
14.60	2256	1907	973	3229	1128	4008	2101	3.319
14.70	2257	1896	982	3239	1129	4007	2111	3.297
14.80	2258	1894	985	3242	1129	4007	2114	3.293
14.90	2254	1892	987	3242	1127	4006	2114	3.284
15.00	2262	1889	989	3252	1131	4010	2121	3.286
15.10	2263	1886	993	3256	1131	4010	2124	3.279
15.20	2263	1884	995	3259	1132	4011	2127	3.274
15.30	2264	1882	996	3260	1132	4011	2128	3.272
15.40	2272	1881	999	3270	1136	4016	2135	3.274
15.50	2276	1879	1000	3276	1138	4016	2138	3.276
15.60	2283	1877	1002	3286	1142	4021	2144	3.278
15.70	2287	1875	1004	3291	1144	4022	2147	3.280
15.80	2291	1874	1005	3296	1146	4024	2150	3.281
15.90	2296	1870	1008	3304	1148	4026	2156	3.277
16.00	2300	1870	1008	3308	1150	4028	2158	3.281
16.10	2300	1868	1012	3312	1150	4030	2162	3.273
16.20	2304	1865	1014	3318	1152	4031	2166	3.272
16.30	2304	1863	1015	3320	1152	4031	2167	3.270
16.40	2308	1862	1016	3325	1154	4033	2171	3.271
16.50	2316	1861	1018	3333	1158	4036	2175	3.276
16.60	2320	1860	1019	3338	1160	4038	2179	3.277
16.70	2324	1859	1021	3345	1162	4042	2183	3.276
16.80	2328	1856	1022	3350	1164	4042	2186	3.277
16.90	2335	1854	1025	3359	1167	4046	2192	3.279
17.00	2342	1852	1028	3370	1171	4051	2199	3.278
17.10	2350	1851	1028	3378	1175	4053	2203	3.285
17.20	2353	1854	1026	3379	1177	4056	2202	3.294
17.30	2357	1851	1028	3385	1179	4057	2207	3.293
17.40	2357	1846	1034	3391	1179	4058	2213	3.280
17.50	2365	1841	1039	3403	1182	4062	2221	3.277
17.60	2365	1836	1042	3407	1183	4061	2225	3.269
17.70	2369	1834	1044	3413	1184	4063	2229	3.268
17.80	2372	1831	1049	3422	1186	4066	2235	3.261
17.90	2373	1826	1053	3425	1186	4065	2239	3.254
18.00	2373	1819	1060	3433	1187	4065	2246	3.239

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
18.10	2380	1814	1064	3444	1190	4069	2254	3.236
18.20	2377	1808	1070	3447	1188	4067	2259	3.221
18.30	2377	1804	1075	3452	1189	4067	2263	3.211
18.40	2381	1802	1076	3457	1190	4069	2266	3.212
18.50	2384	1800	1078	3463	1192	4071	2271	3.211
18.60	2388	1799	1080	3467	1194	4072	2274	3.212
18.70	2395	1797	1082	3477	1197	4076	2279	3.214
18.80	2398	1794	1084	3483	1199	4078	2284	3.212
18.90	2405	1793	1087	3492	1203	4082	2289	3.214
19.00	2406	1793	1085	3491	1203	4081	2288	3.216
19.10	2412	1792	1087	3499	1206	4085	2293	3.220
19.20	2416	1791	1088	3504	1208	4087	2296	3.221
19.30	2419	1788	1090	3510	1210	4088	2300	3.219
19.40	2423	1787	1091	3514	1212	4090	2303	3.220
19.50	2426	1786	1093	3519	1213	4092	2306	3.221
19.60	2426	1784	1095	3521	1213	4092	2308	3.216
19.70	2433	1783	1096	3529	1217	4095	2313	3.220
19.80	2433	1783	1096	3529	1217	4095	2313	3.220
19.90	2437	1786	1093	3529	1218	4097	2311	3.230
20.00	2443	1783	1097	3541	1222	4101	2319	3.227

Project Name: **Taylor Geo-Engineering**
Project Number: **M00991-001**
Sample: **SP-16-13**
Comments: **Samples were compacted to 90% of ASTM D698 at**
Test Number: **S2**

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Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
0.00	-5	0	5758	5753	-3	5755	5755	1.001
0.02	4	23	5736	5740	2	5762	5738	1.001
0.04	4	39	5720	5724	2	5760	5722	1.001
0.06	-1	52	5707	5706	0	5758	5707	1.000
0.08	3	63	5695	5699	2	5760	5697	1.001
0.10	3	74	5685	5688	2	5760	5687	1.001
0.20	-2	115	5644	5642	-1	5758	5643	1.000
0.30	-2	146	5613	5611	-1	5759	5612	1.000
0.40	-3	169	5591	5589	-1	5759	5590	1.000
0.50	-3	185	5574	5571	-1	5757	5572	1.001
0.60	-3	203	5556	5553	-2	5757	5554	1.001
0.70	-4	218	5541	5537	-2	5757	5539	1.001
0.80	-4	233	5526	5521	-2	5757	5524	1.001
0.90	-5	248	5512	5507	-2	5757	5509	1.001
1.00	-5	261	5499	5494	-3	5757	5496	1.001
1.10	-6	275	5485	5479	-3	5757	5482	1.001
1.20	-2	286	5474	5472	-1	5759	5473	1.000
1.30	1148	702	5057	6205	574	6333	5631	1.227
1.40	1593	1068	4691	6284	797	6555	5487	1.340
1.50	1847	1350	4408	6255	923	6682	5332	1.419
1.60	2030	1593	4166	6196	1015	6774	5181	1.487
1.70	2171	1801	3957	6128	1085	6844	5043	1.548
1.80	2293	1992	3767	6060	1147	6905	4913	1.609
1.90	2390	2154	3605	5995	1195	6954	4800	1.663
2.00	2473	2293	3466	5938	1237	6995	4702	1.714
2.10	2547	2414	3345	5892	1274	7032	4619	1.762
2.20	2613	2524	3236	5849	1307	7066	4543	1.808
2.30	2666	2614	3145	5811	1333	7092	4478	1.848
2.40	2718	2697	3081	5799	1359	7138	4440	1.882
2.50	2767	2776	2983	5750	1383	7142	4366	1.928
2.60	2811	2850	2909	5720	1405	7164	4315	1.966
2.70	2854	2914	2845	5699	1427	7186	4272	2.003
2.80	2890	2974	2785	5675	1445	7203	4230	2.038
2.90	2925	3030	2729	5653	1462	7221	4191	2.072
3.00	2955	3081	2679	5634	1478	7237	4156	2.103
3.10	2982	3125	2634	5616	1491	7250	4125	2.132
3.20	3008	3167	2592	5600	1504	7263	4096	2.161
3.30	3038	3206	2553	5592	1519	7278	4072	2.190
3.40	3056	3249	2510	5566	1528	7287	4038	2.218
3.50	3078	3285	2474	5551	1539	7298	4012	2.244
3.60	3100	3318	2442	5542	1550	7310	3992	2.269
3.70	3113	3351	2408	5521	1557	7315	3964	2.293
3.80	3122	3380	2380	5502	1561	7321	3941	2.312
3.90	3144	3407	2352	5495	1572	7331	3924	2.337
4.00	3153	3428	2331	5483	1576	7335	3907	2.353
4.10	3170	3452	2307	5477	1585	7344	3892	2.374
4.20	3183	3476	2283	5466	1592	7350	3874	2.395
4.30	3196	3500	2259	5456	1598	7357	3857	2.415
4.40	3214	3518	2240	5454	1607	7365	3847	2.434
4.50	3227	3541	2218	5445	1613	7372	3831	2.455
4.60	3244	3560	2199	5443	1622	7382	3821	2.475
4.70	3261	3579	2181	5442	1630	7390	3811	2.495
4.80	3278	3597	2163	5441	1639	7399	3802	2.515
4.90	3287	3615	2143	5430	1643	7402	3787	2.533
5.00	3304	3631	2128	5432	1652	7411	3780	2.552
5.10	3316	3646	2113	5429	1658	7417	3771	2.570
5.20	3329	3656	2102	5431	1665	7423	3767	2.584

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
5.30	3346	3668	2091	5437	1673	7432	3764	2.601
5.40	3355	3685	2074	5429	1677	7436	3751	2.617
5.50	3363	3696	2062	5426	1682	7440	3744	2.631
5.60	3376	3709	2050	5425	1688	7447	3737	2.647
5.70	3392	3721	2038	5430	1696	7455	3734	2.665
5.80	3405	3731	2027	5432	1703	7461	3730	2.680
5.90	3422	3741	2018	5440	1711	7470	3729	2.696
6.00	3434	3750	2009	5443	1717	7476	3726	2.710
6.10	3451	3761	1998	5449	1725	7484	3723	2.727
6.20	3463	3764	1995	5458	1732	7490	3726	2.736
6.30	3480	3771	1988	5467	1740	7499	3727	2.751
6.40	3492	3779	1979	5471	1746	7505	3725	2.764
6.50	3500	3789	1970	5470	1750	7509	3720	2.777
6.60	3512	3798	1962	5474	1756	7516	3718	2.790
6.70	3529	3806	1952	5481	1764	7523	3717	2.807
6.80	3537	3812	1948	5484	1768	7528	3716	2.816
6.90	3545	3819	1939	5484	1773	7531	3712	2.828
7.00	3549	3825	1934	5482	1774	7533	3708	2.835
7.10	3557	3831	1928	5485	1779	7537	3706	2.845
7.20	3565	3843	1916	5481	1783	7541	3699	2.861
7.30	3573	3854	1904	5477	1786	7545	3691	2.876
7.40	3573	3856	1903	5476	1786	7545	3690	2.877
7.50	3581	3858	1901	5481	1790	7549	3691	2.884
7.60	3584	3857	1902	5486	1792	7551	3694	2.885
7.70	3600	3854	1904	5505	1800	7559	3705	2.891
7.80	3604	3854	1904	5509	1802	7561	3706	2.893
7.90	3616	3851	1908	5524	1808	7567	3716	2.895
8.00	3624	3842	1917	5541	1812	7571	3729	2.890
8.10	3640	3834	1924	5564	1820	7579	3744	2.892
8.20	3644	3832	1927	5570	1822	7580	3748	2.891
8.30	3655	3837	1922	5577	1828	7586	3750	2.902
8.40	3667	3842	1917	5584	1834	7592	3751	2.913
8.50	3679	3850	1910	5589	1839	7599	3750	2.926
8.60	3694	3857	1902	5596	1847	7606	3749	2.942
8.70	3706	3863	1896	5602	1853	7612	3749	2.955
8.80	3713	3868	1890	5604	1857	7615	3747	2.965
8.90	3725	3874	1884	5609	1863	7621	3747	2.977
9.00	3729	3879	1880	5608	1864	7623	3744	2.984
9.10	3740	3885	1874	5614	1870	7629	3744	2.996
9.20	3748	3888	1870	5618	1874	7632	3744	3.004
9.30	3759	3893	1866	5625	1880	7638	3745	3.015
9.40	3774	3898	1862	5636	1887	7647	3749	3.027
9.50	3786	3901	1859	5644	1893	7653	3751	3.037
9.60	3797	3905	1854	5651	1899	7657	3752	3.048
9.70	3808	3908	1850	5659	1904	7663	3755	3.058
9.80	3816	3911	1848	5664	1908	7666	3756	3.065
9.90	3831	3913	1847	5678	1915	7675	3762	3.074
10.00	3838	3914	1845	5683	1919	7678	3764	3.081
10.10	3845	3916	1843	5689	1923	7682	3766	3.086
10.20	3852	3918	1841	5693	1926	7685	3767	3.092
10.30	3856	3918	1841	5697	1928	7686	3769	3.094
10.40	3863	3919	1841	5704	1931	7691	3772	3.098
10.50	3870	3921	1839	5708	1935	7695	3774	3.105
10.60	3877	3921	1838	5714	1938	7697	3776	3.110
10.70	3880	3922	1836	5716	1940	7699	3776	3.113
10.80	3883	3922	1836	5719	1942	7700	3778	3.114
10.90	3890	3922	1836	5726	1945	7704	3781	3.118
11.00	3893	3924	1835	5728	1947	7705	3782	3.121
11.10	3892	3922	1838	5730	1946	7706	3784	3.118
11.20	3899	3922	1838	5737	1950	7709	3787	3.122
11.30	3906	3922	1836	5743	1953	7712	3789	3.127
11.40	3921	3922	1836	5757	1960	7719	3797	3.135
11.50	3924	3921	1838	5761	1962	7721	3799	3.135
11.60	3934	3921	1838	5772	1967	7726	3805	3.141

Axial strain, ε (%)	σ_d ($\sigma_1-\sigma_3$) (psf)	Δ pore press., Δu (psf)	Effective σ'_3 (psf)	Effective σ'_1 (psf)	q ($\sigma_1-\sigma_3$)/2 (psf)	p ($\sigma_1+\sigma_3$)/2 (psf)	p' ($\sigma'_1+\sigma'_3$)/2 (psf)	σ'_1/σ'_3
11.70	3941	3920	1840	5781	1971	7730	3811	3.142
11.80	3952	3920	1840	5792	1976	7736	3816	3.148
11.90	3959	3919	1840	5799	1979	7738	3819	3.152
12.00	3969	3918	1841	5810	1985	7743	3826	3.156
12.10	3980	3916	1842	5822	1990	7749	3832	3.160
12.20	3990	3915	1843	5834	1995	7754	3839	3.165
12.30	3989	3913	1846	5835	1995	7753	3840	3.161
12.40	4000	3913	1846	5846	2000	7759	3846	3.167
12.50	4010	3911	1849	5859	2005	7765	3854	3.169
12.60	4017	3909	1849	5866	2008	7767	3858	3.172
12.70	4023	3907	1853	5876	2012	7772	3864	3.171
12.80	4030	3905	1855	5885	2015	7775	3870	3.172
12.90	4040	3904	1855	5895	2020	7779	3875	3.178
13.00	4047	3900	1859	5905	2023	7782	3882	3.177
13.10	4061	3899	1860	5920	2030	7789	3890	3.183
13.20	4075	3897	1862	5937	2037	7796	3900	3.188
13.30	4081	3894	1865	5946	2041	7799	3905	3.189
13.40	4084	3891	1868	5952	2042	7801	3910	3.186
13.50	4094	3890	1869	5963	2047	7806	3916	3.190
13.60	4104	3886	1873	5976	2052	7811	3925	3.191
13.70	4106	3885	1874	5980	2053	7812	3927	3.191
13.80	4112	3880	1879	5991	2056	7815	3935	3.189
13.90	4119	3879	1880	5998	2059	7818	3939	3.191
14.00	4121	3875	1883	6004	2061	7819	3944	3.188
14.10	4127	3873	1887	6014	2064	7823	3950	3.187
14.20	4133	3871	1888	6021	2067	7825	3955	3.189
14.30	4136	3868	1890	6026	2068	7827	3958	3.188
14.40	4138	3866	1893	6031	2069	7828	3962	3.186
14.50	4136	3863	1896	6033	2068	7827	3964	3.182
14.60	4143	3860	1898	6041	2071	7830	3970	3.182
14.70	4145	3859	1900	6044	2072	7831	3972	3.182
14.80	4147	3856	1904	6051	2074	7833	3978	3.178
14.90	4157	3852	1907	6063	2078	7837	3985	3.180
15.00	4163	3850	1909	6072	2081	7840	3990	3.181
15.10	4169	3849	1910	6079	2084	7843	3995	3.182
15.20	4178	3846	1914	6092	2089	7849	4003	3.183
15.30	4188	3843	1916	6104	2094	7853	4010	3.186
15.40	4194	3840	1918	6112	2097	7856	4015	3.186
15.50	4203	3838	1921	6124	2102	7860	4022	3.188
15.60	4209	3836	1923	6132	2105	7863	4028	3.189
15.70	4215	3833	1927	6141	2107	7867	4034	3.188
15.80	4217	3830	1929	6146	2108	7867	4037	3.186
15.90	4223	3826	1932	6155	2111	7870	4044	3.185
16.00	4232	3823	1936	6168	2116	7875	4052	3.186
16.10	4238	3820	1938	6176	2119	7877	4057	3.186
16.20	4243	3817	1942	6185	2122	7880	4063	3.185
16.30	4249	3813	1945	6194	2124	7883	4070	3.184
16.40	4251	3810	1949	6200	2125	7884	4074	3.181
16.50	4260	3808	1951	6211	2130	7889	4081	3.183
16.60	4269	3804	1955	6224	2135	7893	4089	3.184
16.70	4275	3799	1959	6234	2137	7896	4097	3.182
16.80	4291	3797	1963	6254	2146	7905	4108	3.186
16.90	4300	3795	1964	6264	2150	7909	4114	3.189
17.00	4306	3791	1968	6273	2153	7911	4120	3.188
17.10	4311	3788	1971	6282	2156	7914	4127	3.187
17.20	4316	3782	1977	6293	2158	7917	4135	3.183
17.30	4322	3778	1980	6302	2161	7920	4141	3.182
17.40	4327	3774	1985	6312	2164	7922	4149	3.180
17.50	4329	3768	1991	6320	2164	7923	4155	3.174
17.60	4334	3763	1996	6330	2167	7926	4163	3.172
17.70	4335	3758	2000	6336	2168	7926	4168	3.167
17.80	4337	3754	2006	6343	2169	7928	4175	3.162
17.90	4342	3750	2009	6351	2171	7930	4180	3.162
18.00	4344	3745	2013	6357	2172	7931	4185	3.158

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
18.10	4353	3740	2019	6372	2176	7935	4195	3.156
18.20	4358	3735	2024	6381	2179	7938	4203	3.153
18.30	4363	3729	2031	6394	2181	7941	4212	3.148
18.40	4375	3738	2021	6396	2188	7947	4209	3.164
18.50	4380	3735	2024	6404	2190	7949	4214	3.164
18.60	4392	3712	2047	6439	2196	7955	4243	3.145
18.70	4394	3699	2061	6455	2197	7957	4258	3.132
18.80	4402	3689	2069	6472	2201	7960	4271	3.127
18.90	4407	3682	2077	6484	2204	7962	4280	3.122
19.00	4412	3678	2081	6493	2206	7965	4287	3.120
19.10	4420	3672	2087	6507	2210	7969	4297	3.118
19.20	4422	3666	2093	6515	2211	7970	4304	3.113
19.30	4426	3660	2099	6525	2213	7972	4312	3.109
19.40	4431	3656	2102	6534	2216	7974	4318	3.108
19.50	4436	3653	2106	6542	2218	7977	4324	3.107
19.60	4441	3648	2110	6551	2220	7979	4331	3.104
19.70	4445	3647	2112	6557	2223	7981	4334	3.105
19.80	4454	3642	2116	6570	2227	7986	4343	3.104
19.90	4462	3654	2106	6568	2231	7991	4337	3.119
20.00	4466	3649	2109	6576	2233	7992	4343	3.118

Project Name: Taylor Geo-Engineering
Project Number: M00991-001
Sample: SP-16-13
Comments: Samples were compacted to 90% of ASTM D698 at
Test Number: S3

Z:\PROJECTS\M00991_Taylor_Geo-Engineering\001\[GTXCU3v1_SP-16-13.xls]s3

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
0.00	-14	0	11521	11507	-7	11514	11514	1.001
0.02	148	30	11492	11640	74	11596	11566	1.013
0.04	148	46	11477	11624	74	11596	11550	1.013
0.06	156	61	11461	11618	78	11601	11540	1.014
0.08	165	74	11450	11615	83	11606	11532	1.014
0.10	174	87	11436	11610	87	11610	11523	1.015
0.20	205	138	11385	11590	102	11626	11488	1.018
0.30	236	182	11341	11577	118	11641	11459	1.021
0.40	271	219	11303	11574	135	11658	11439	1.024
0.50	1560	450	11073	12632	780	12302	11852	1.141
0.60	2694	881	10642	13335	1347	12869	11988	1.253
0.70	3312	1313	10208	13520	1656	13177	11864	1.324
0.80	3750	1787	9735	13485	1875	13397	11610	1.385
0.90	4075	2255	9269	13344	2038	13562	11307	1.440
1.00	4347	2673	8850	13197	2174	13696	11023	1.491
1.10	4569	3058	8464	13034	2285	13807	10749	1.540
1.20	4764	3407	8115	12880	2382	13905	10498	1.587
1.30	4928	3710	7812	12740	2464	13986	10276	1.631
1.40	5069	3986	7537	12606	2534	14057	10071	1.673
1.50	5196	4226	7297	12493	2598	14120	9895	1.712
1.60	5310	4453	7068	12378	2655	14176	9723	1.751
1.70	5410	4655	6867	12277	2705	14228	9572	1.788
1.80	5502	4848	6675	12176	2751	14273	9426	1.824
1.90	5597	5021	6503	12100	2799	14322	9301	1.861
2.00	5675	5181	6341	12016	2837	14360	9178	1.895
2.10	5748	5331	6191	11939	2874	14396	9065	1.928
2.20	5821	5472	6051	11871	2910	14433	8961	1.962
2.30	5885	5599	5923	11807	2942	14465	8865	1.994
2.40	5940	5718	5805	11744	2970	14492	8774	2.023
2.50	6003	5831	5691	11694	3002	14524	8693	2.055
2.60	6058	5923	5600	11658	3029	14551	8629	2.082
2.70	6108	6014	5508	11617	3054	14577	8563	2.109
2.80	6154	6103	5419	11573	3077	14599	8496	2.136
2.90	6200	6187	5335	11535	3100	14622	8435	2.162
3.00	6245	6272	5251	11496	3123	14645	8373	2.189
3.10	6286	6348	5175	11461	3143	14666	8318	2.215
3.20	6323	6418	5104	11427	3162	14684	8266	2.239
3.30	6360	6484	5039	11398	3180	14702	8219	2.262
3.40	6396	6546	4977	11373	3198	14720	8175	2.285
3.50	6428	6609	4915	11343	3214	14738	8129	2.308
3.60	6460	6656	4867	11327	3230	14752	8097	2.327
3.70	6488	6706	4816	11304	3244	14766	8060	2.347
3.80	6519	6754	4768	11287	3260	14782	8028	2.367
3.90	6551	6802	4720	11271	3276	14798	7996	2.388
4.00	6578	6848	4675	11253	3289	14812	7964	2.407
4.10	6606	6895	4628	11233	3303	14825	7930	2.427
4.20	6633	6933	4589	11222	3316	14839	7905	2.445
4.30	6664	6974	4548	11212	3332	14854	7880	2.465
4.40	6695	7011	4513	11208	3348	14871	7861	2.484
4.50	6727	7047	4475	11202	3363	14886	7839	2.503
4.60	6749	7085	4438	11187	3375	14897	7813	2.521
4.70	6776	7107	4416	11192	3388	14910	7804	2.535
4.80	6807	7135	4388	11195	3404	14926	7791	2.551
4.90	6829	7165	4357	11187	3415	14937	7772	2.567
5.00	6860	7190	4333	11193	3430	14953	7763	2.583
5.10	6887	7220	4302	11189	3443	14966	7745	2.601
5.20	6913	7246	4276	11190	3457	14979	7733	2.617

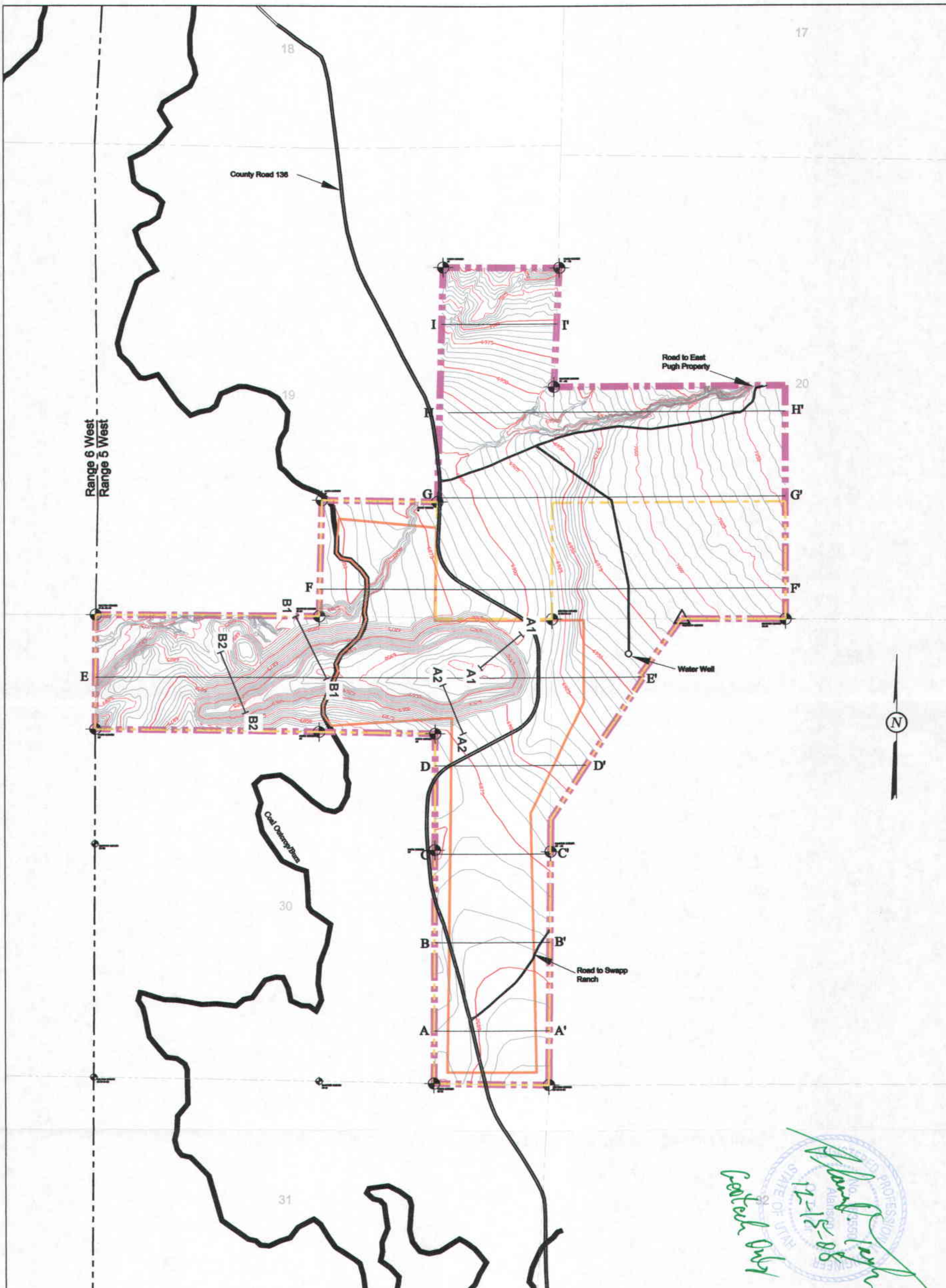
Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
5.30	6940	7272	4251	11190	3470	14992	7720	2.633
5.40	6966	7297	4226	11192	3483	15005	7709	2.648
5.50	6992	7319	4204	11196	3496	15018	7700	2.663
5.60	7018	7340	4184	11202	3509	15033	7693	2.678
5.70	7049	7360	4163	11211	3524	15047	7687	2.693
5.80	7079	7376	4146	11225	3540	15062	7686	2.707
5.90	7105	7390	4132	11237	3552	15075	7685	2.719
6.00	7126	7404	4118	11245	3563	15086	7681	2.731
6.10	7148	7418	4104	11252	3574	15096	7678	2.742
6.20	7174	7436	4087	11260	3587	15109	7673	2.755
6.30	7200	7451	4071	11271	3600	15122	7671	2.768
6.40	7217	7467	4056	11273	3608	15132	7664	2.779
6.50	7234	7482	4041	11275	3617	15139	7658	2.790
6.60	7255	7496	4027	11282	3628	15150	7654	2.802
6.70	7276	7508	4014	11290	3638	15160	7652	2.813
6.80	7293	7519	4003	11297	3647	15169	7650	2.822
6.90	7310	7532	3991	11300	3655	15177	7646	2.832
7.00	7327	7541	3981	11308	3663	15186	7645	2.840
7.10	7344	7547	3975	11319	3672	15194	7647	2.847
7.20	7352	7553	3969	11321	3676	15198	7645	2.852
7.30	7373	7559	3964	11336	3686	15209	7650	2.860
7.40	7381	7569	3954	11335	3691	15214	7645	2.867
7.50	7402	7580	3943	11344	3701	15223	7643	2.877
7.60	7419	7588	3934	11353	3709	15232	7644	2.886
7.70	7431	7596	3926	11357	3715	15238	7642	2.893
7.80	7447	7605	3918	11365	3724	15246	7642	2.901
7.90	7464	7614	3910	11373	3732	15255	7641	2.909
8.00	7480	7619	3904	11384	3740	15262	7644	2.916
8.10	7496	7622	3900	11396	3748	15270	7648	2.922
8.20	7517	7627	3897	11413	3758	15282	7655	2.929
8.30	7533	7633	3891	11424	3766	15290	7657	2.936
8.40	7553	7637	3885	11438	3777	15299	7662	2.944
8.50	7569	7640	3883	11452	3785	15307	7667	2.949
8.60	7589	7643	3879	11468	3795	15317	7674	2.956
8.70	7605	7638	3884	11489	3803	15325	7686	2.958
8.80	7625	7636	3886	11511	3813	15335	7699	2.962
8.90	7645	7637	3885	11530	3823	15345	7708	2.968
9.00	7665	7638	3884	11549	3832	15355	7716	2.973
9.10	7685	7640	3883	11567	3842	15365	7725	2.979
9.20	7708	7642	3880	11589	3854	15377	7735	2.986
9.30	7728	7646	3877	11605	3864	15386	7741	2.993
9.40	7752	7649	3873	11625	3876	15398	7749	3.001
9.50	7767	7649	3873	11641	3884	15406	7757	3.005
9.60	7791	7654	3869	11659	3895	15418	7764	3.014
9.70	7810	7654	3869	11679	3905	15428	7774	3.019
9.80	7825	7656	3866	11692	3913	15435	7779	3.024
9.90	7849	7658	3865	11714	3924	15448	7790	3.031
10.00	7860	7660	3863	11723	3930	15452	7793	3.035
10.10	7875	7660	3864	11739	3938	15461	7802	3.038
10.20	7890	7658	3864	11754	3945	15467	7809	3.042
10.30	7905	7695	3829	11734	3953	15476	7782	3.065
10.40	7916	7708	3815	11731	3958	15480	7773	3.075
10.50	7927	7698	3824	11751	3964	15486	7788	3.073
10.60	7942	7643	3878	11820	3971	15492	7849	3.048
10.70	7957	7669	3855	11811	3978	15502	7833	3.064
10.80	7960	7626	3897	11856	3980	15502	7877	3.043
10.90	7970	7592	3931	11901	3985	15508	7916	3.028
11.00	7981	7574	3947	11928	3991	15512	7938	3.022
11.10	7992	7565	3958	11949	3996	15518	7953	3.019
11.20	8002	7557	3966	11968	4001	15524	7967	3.018
11.30	8013	7562	3960	11973	4006	15529	7966	3.023
11.40	8027	7567	3955	11983	4014	15536	7969	3.029
11.50	8038	7569	3954	11992	4019	15542	7973	3.033
11.60	8044	7576	3946	11990	4022	15544	7968	3.039

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
11.70	8058	7582	3940	11998	4029	15552	7969	3.045
11.80	8073	7587	3935	12008	4036	15559	7972	3.051
11.90	8087	7590	3932	12019	4044	15566	7975	3.057
12.00	8097	7594	3928	12026	4049	15571	7977	3.061
12.10	8115	7597	3925	12040	4058	15580	7983	3.068
12.20	8129	7599	3924	12053	4065	15587	7988	3.072
12.30	8143	7601	3921	12065	4072	15594	7993	3.077
12.40	8161	7605	3919	12080	4081	15604	8000	3.082
12.50	8171	7605	3917	12088	4086	15607	8002	3.086
12.60	8185	7605	3918	12103	4093	15615	8010	3.089
12.70	8207	7605	3918	12125	4103	15626	8021	3.095
12.80	8228	7603	3918	12146	4114	15635	8032	3.100
12.90	8242	7600	3923	12165	4121	15643	8044	3.101
13.00	8256	7596	3926	12182	4128	15650	8054	3.103
13.10	8273	7594	3928	12202	4137	15659	8065	3.106
13.20	8294	7592	3931	12225	4147	15670	8078	3.110
13.30	8308	7586	3937	12245	4154	15676	8091	3.110
13.40	8325	7581	3941	12267	4163	15685	8104	3.112
13.50	8342	7575	3948	12291	4171	15695	8120	3.113
13.60	8360	7571	3952	12312	4180	15702	8132	3.115
13.70	8369	7565	3959	12328	4185	15708	8143	3.114
13.80	8390	7560	3962	12352	4195	15717	8157	3.117
13.90	8399	7554	3968	12368	4200	15722	8168	3.117
14.00	8408	7547	3975	12384	4204	15727	8180	3.115
14.10	8414	7540	3982	12396	4207	15729	8189	3.113
14.20	8431	7533	3989	12420	4215	15738	8205	3.113
14.30	8440	7525	3999	12438	4220	15743	8219	3.111
14.40	8449	7519	4003	12452	4224	15747	8228	3.110
14.50	8454	7512	4010	12464	4227	15749	8237	3.108
14.60	8463	7504	4019	12481	4231	15754	8250	3.106
14.70	8468	7494	4028	12496	4234	15756	8262	3.102
14.80	8477	7485	4037	12514	4238	15761	8276	3.100
14.90	8497	7476	4048	12545	4249	15772	8296	3.099
15.00	8510	7467	4055	12564	4255	15777	8310	3.099
15.10	8518	7462	4062	12580	4259	15783	8321	3.097
15.20	8531	7453	4069	12600	4265	15788	8334	3.097
15.30	8539	7445	4077	12616	4270	15792	8347	3.094
15.40	8548	7438	4084	12632	4274	15796	8358	3.093
15.50	8564	7432	4090	12654	4282	15804	8372	3.094
15.60	8584	7423	4099	12683	4292	15814	8391	3.094
15.70	8600	7414	4109	12709	4300	15822	8409	3.093
15.80	8612	7407	4116	12728	4306	15828	8422	3.092
15.90	8632	7400	4123	12755	4316	15838	8439	3.094
16.00	8648	7391	4131	12779	4324	15846	8455	3.093
16.10	8656	7386	4138	12794	4328	15851	8466	3.092
16.20	8668	7377	4146	12814	4334	15857	8480	3.090
16.30	8683	7369	4155	12838	4342	15865	8496	3.090
16.40	8691	7361	4163	12854	4346	15869	8508	3.088
16.50	8707	7354	4169	12875	4354	15876	8522	3.089
16.60	8715	7346	4177	12892	4358	15880	8534	3.087
16.70	8727	7337	4186	12913	4363	15887	8549	3.085
16.80	8734	7330	4192	12926	4367	15890	8559	3.084
16.90	8742	7325	4198	12940	4371	15894	8569	3.083
17.00	8754	7318	4205	12959	4377	15899	8582	3.082
17.10	8758	7309	4213	12971	4379	15901	8592	3.079
17.20	8758	7302	4220	12978	4379	15901	8599	3.075
17.30	8773	7297	4226	12999	4387	15909	8613	3.076
17.40	8773	7288	4234	13007	4387	15909	8621	3.072
17.50	8773	7280	4244	13017	4387	15910	8630	3.068
17.60	8785	7274	4249	13034	4392	15916	8642	3.067
17.70	8785	7267	4255	13040	4392	15915	8648	3.064
17.80	8781	7259	4263	13044	4391	15913	8654	3.060
17.90	8789	7253	4269	13058	4394	15917	8664	3.059
18.00	8789	7246	4276	13065	4394	15917	8671	3.055

Axial strain, ε (%)	σd (σ1−σ3) (psf)	Δ pore press., Δu (psf)	Effective σ'3 (psf)	Effective σ'1 (psf)	q (σ1−σ3)/2 (psf)	p (σ1+σ3)/2 (psf)	p' (σ'1+σ'3)/2 (psf)	σ'1/σ'3
18.10	8792	7238	4284	13077	4396	15919	8681	3.052
18.20	8792	7233	4289	13081	4396	15918	8685	3.050
18.30	8799	7226	4296	13096	4400	15922	8696	3.048
18.40	8799	7218	4304	13104	4400	15922	8704	3.044
18.50	8806	7210	4313	13119	4403	15926	8716	3.042
18.60	8810	7204	4318	13128	4405	15927	8723	3.040
18.70	8817	7198	4325	13142	4409	15932	8734	3.038
18.80	8820	7190	4333	13153	4410	15933	8743	3.036
18.90	8827	7185	4338	13166	4414	15937	8752	3.035
19.00	8834	7179	4343	13177	4417	15940	8760	3.034
19.10	8845	7175	4348	13193	4423	15945	8770	3.034
19.20	8852	7168	4356	13208	4426	15949	8782	3.032
19.30	8855	7162	4361	13216	4428	15950	8788	3.031
19.40	8866	7157	4365	13231	4433	15955	8798	3.031
19.50	8872	7150	4374	13246	4436	15960	8810	3.029
19.60	8879	7143	4379	13258	4440	15962	8819	3.027
19.70	8886	7137	4386	13272	4443	15966	8829	3.026
19.80	8889	7129	4393	13282	4444	15967	8838	3.023
19.90	8895	7123	4399	13294	4448	15970	8847	3.022
20.00	8909	7116	4407	13316	4454	15978	8862	3.021

APPENDIX D

DESIGN AND DETAIL SHEETS



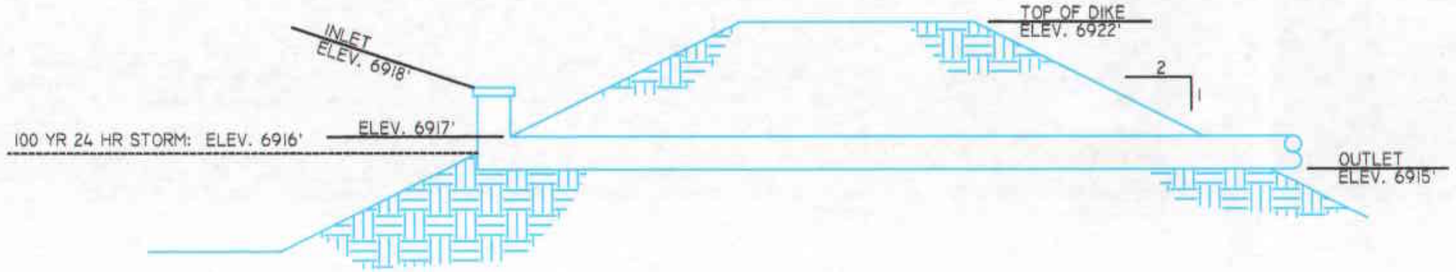
CONTOURS ARE AT 5' INTERVALS.

PERMIT BOUNDARY PRIVATE COAL OWNERSHIP COAL LINE BOUNDARY COAL RECOVERY LINE SECTION LINE FOUND SECTION CORNER FOUND PROPERTY CORNER	DRAWN BY: C. McCOURT DRAWING: 5-35 JOB NUMBER: 1400	CHECKED BY: GG DATE: 11/20/08 SCALE: 1" = 500' SHEET	REVISIONS DATE: BY:	POST MINING TOPOGRAPHY PREFERRED SCENARIO COAL HOLLOW PROJECT ALTON, UTAH DRAWING: 5-35	Figure No. 11

Coal Hollow Project

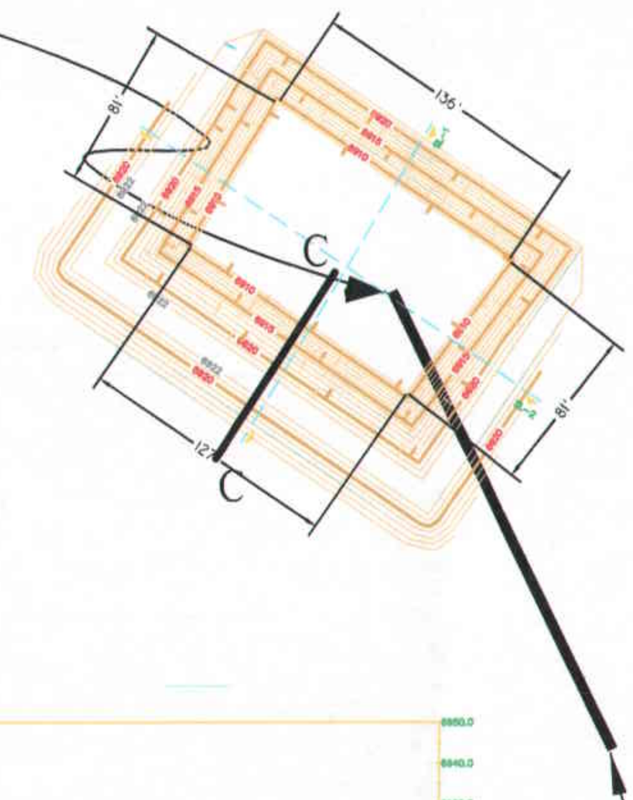
463 North 100 West, Suite 1
Cedar City, Utah 84720
Phone (435)867-5331
Fax (435)867-1192

12-12-08
Cadastral Only

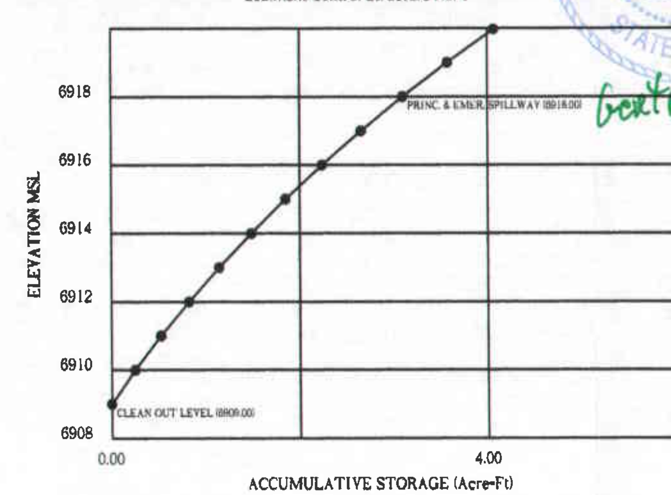


TYPICAL CROSS SECTION
Not to Scale

24 inch Drop Pipe Spillway
Top of riser 6918'
Bottom of riser 6915'



24 inch outlet 6915'



STORAGE VOLUME COMPUTATIONS

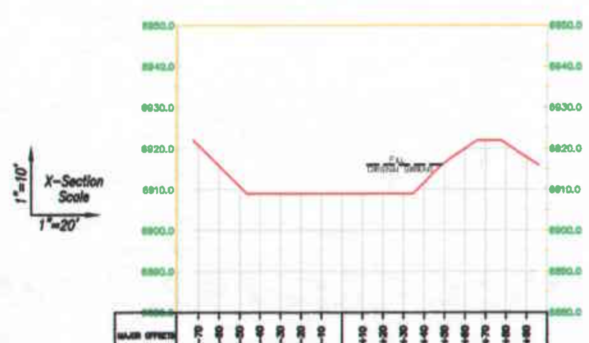
Sediment Control Structure No. 1

ELEV. (ft)	WIDTH (ft)	LENGTH (ft)	AREA (ac)	AVG. AREA (ac)	INTERVAL (ft)	STORAGE (ac-ft)	ACC. STORAGE (ac-ft)	STAGE INTERVAL (ft)
6909.00	NA	NA	0.2320					
6910.00	NA	NA	0.2650	0.2485	1.00	0.2485	0.2485	1.00
6911.00	NA	NA	0.2870	0.2760	1.00	0.2760	0.5245	2.00
6912.00	NA	NA	0.3090	0.2980	1.00	0.2980	0.8225	3.00
6913.00	NA	NA	0.3310	0.3200	1.00	0.3200	1.1425	4.00
6914.00	NA	NA	0.3540	0.3425	1.00	0.3425	1.4850	5.00
6915.00	NA	NA	0.3770	0.3655	1.00	0.3655	1.8505	6.00
6916.00	NA	NA	0.4020	0.3895	1.00	0.3895	2.2400	7.00
6917.00	NA	NA	0.4290	0.4155	1.00	0.4155	2.6555	8.00
6918.00	NA	NA	0.4590	0.4440	1.00	0.4440	3.0995	9.00
6919.00	NA	NA	0.4920	0.4755	1.00	0.4755	3.5750	10.00
6920.00	NA	NA	0.5190	0.5055	0.98	0.4954	4.0704	10.98
6922.00								

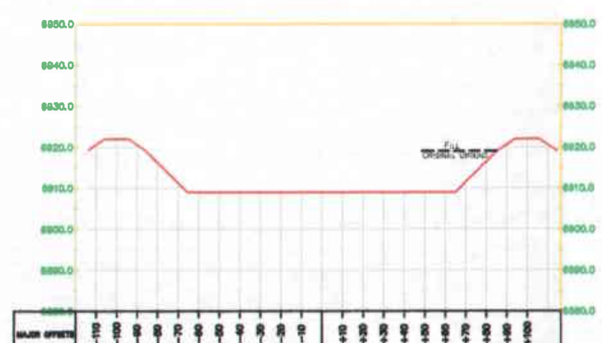
Pond #1

Required Storage for 100 year, 24 event = 2.57 acre/ft

1"=10"
X-Section Scale
1"=20'



SL-1



SL-2

Alan D. Taylor
12-15-08
REGISTERED PROFESSIONAL ENGINEER
No. 183550
Alan D. Taylor
STATE OF UTAH

DRAWN BY:	CHECKED BY:
C. MCCOURT	CM
DRAWING:	DATE:
5-28	04/20/07
	SCALE:
	1" = 80'
JOB NUMBER: 1400	SHEET

REVISIONS

DATE:	BY:

SEDIMENT IMPOUNDMENT 1
DESIGN & DETAILS

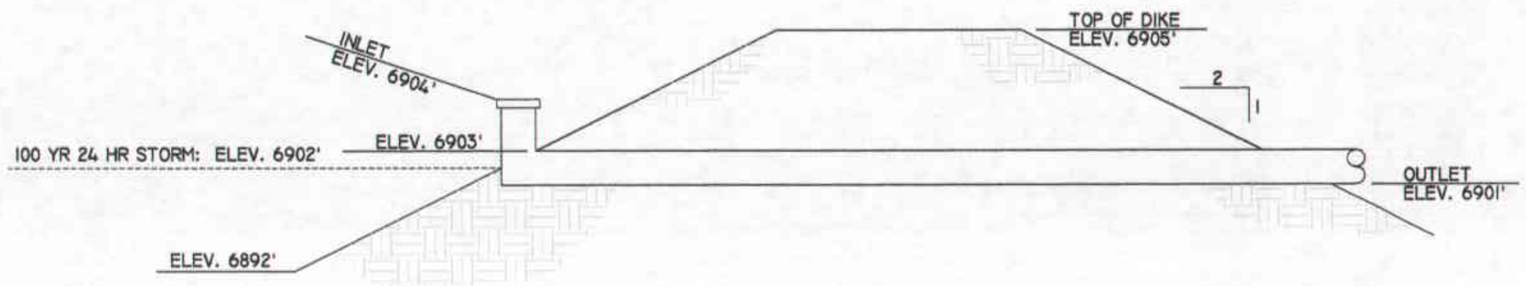
COAL HOLLOW PROJECT
ALTON, UTAH

DRAWING: 5-28

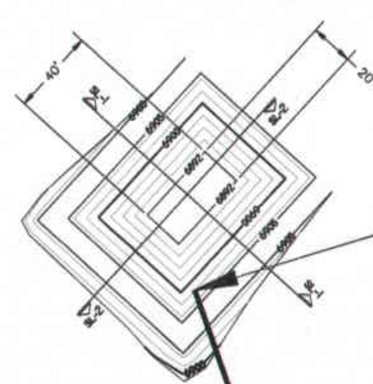
Registered Professional Engineer
275875-2202
CHRIS R. McCOURT
State of Utah

Coal Hollow Project
615 North, 400 East
P.O. Box 1230
Huntington, Utah 84528
Phone (435)687-5310
Fax (435)687-5311

Figure No. 12



TYPICAL CROSS SECTION
Not to Scale

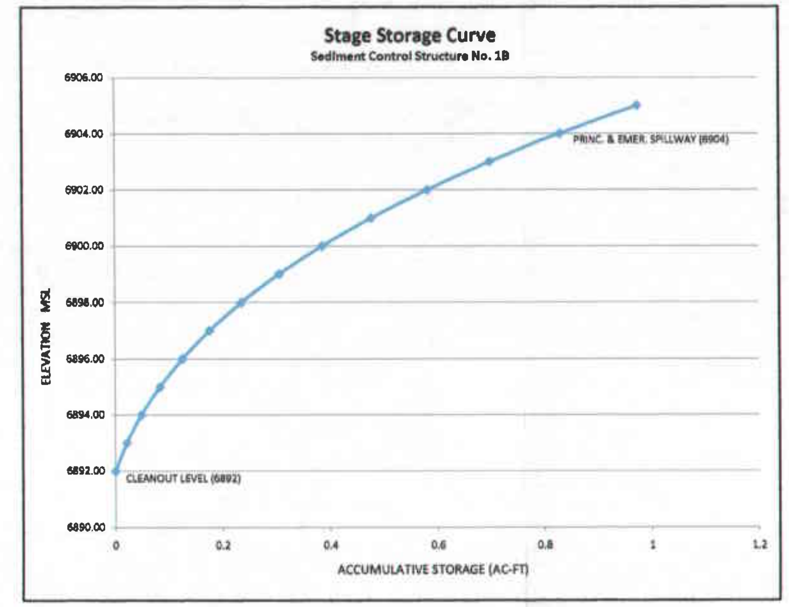


Required Storage for 100 year, 24 event = 0.50 acre/ft

24 inch Drop Pipe Spillway
Top of riser 6904'
Bottom of riser 6902'

24 inch outlet 6901'

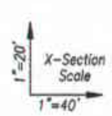
Pond #1B

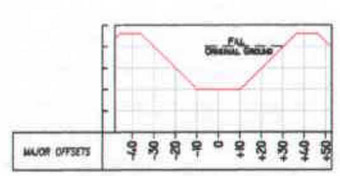


STORAGE VOLUME COMPUTATIONS

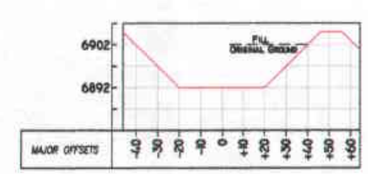
Sediment Control Structure No. 1B

ELEV. (ft)	WIDTH (ft)	LENGTH (ft)	AREA (ac)	AVG. AREA (ac)	INTERVAL (ft)	STORAGE (ac-ft)	ACC. STORAGE (ac-ft)	STAGE INTERVAL (ft)
6892.00	NA	NA	0.0184					
6893.00	NA	NA	0.0242	0.0213	1.00	0.0213	0.0213	1.00
6894.00	NA	NA	0.0309	0.0276	1.00	0.0276	0.0489	2.00
6895.00	NA	NA	0.0382	0.0346	1.00	0.0346	0.0834	3.00
6896.00	NA	NA	0.0463	0.0423	1.00	0.0423	0.1257	4.00
6897.00	NA	NA	0.0551	0.0507	1.00	0.0507	0.1764	5.00
6898.00	NA	NA	0.0646	0.0599	1.00	0.0599	0.2362	6.00
6899.00	NA	NA	0.0749	0.0698	1.00	0.0698	0.3060	7.00
6900.00	NA	NA	0.0859	0.0804	1.00	0.0804	0.3864	8.00
6901.00	NA	NA	0.0977	0.0918	1.00	0.0918	0.4782	9.00
6902.00	NA	NA	0.1102	0.1040	1.00	0.1040	0.5821	10.00
6903.00	NA	NA	0.1234	0.1168	1.00	0.1168	0.6989	11.00
6904.00	NA	NA	0.1374	0.1304	1.00	0.1304	0.8293	12.00
6905.00	NA	NA	0.1521	0.1448	1.00	0.1448	0.9741	13.00





SL-1



SL-2

REGISTERED PROFESSIONAL ENGINEER
No. 165550
Alanson L. Taylor
STATE OF UTAH
12-15-08
Certified duly

Coal Hollow Project
463 North 100 West, Suite 1
Cedar City, Utah 84720
Phone (435) 867-5331
Fax (435) 867-1192

275875-2202
CHRIS R. McCOURT

SEDIMENT IMPOUNDMENT 1B DETAILS

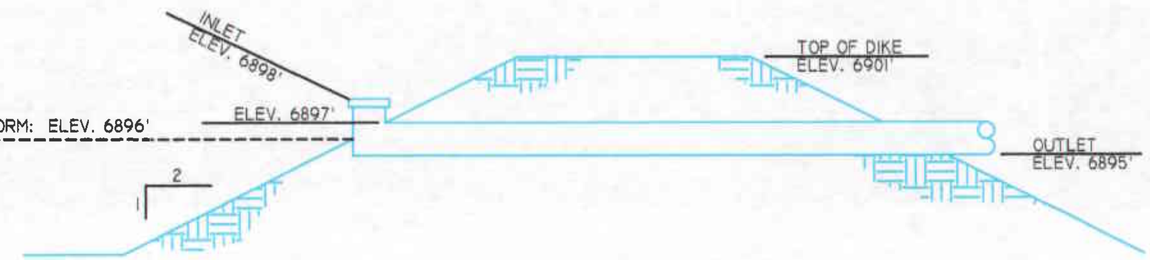
COAL HOLLOW PROJECT
ALTON, UTAH

DRAWING: 5-28B

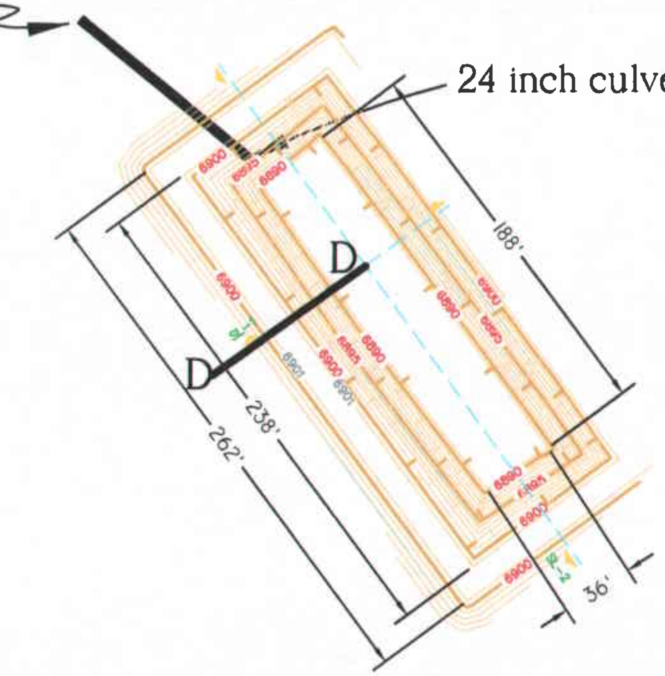
REVISIONS	
DATE:	BY:

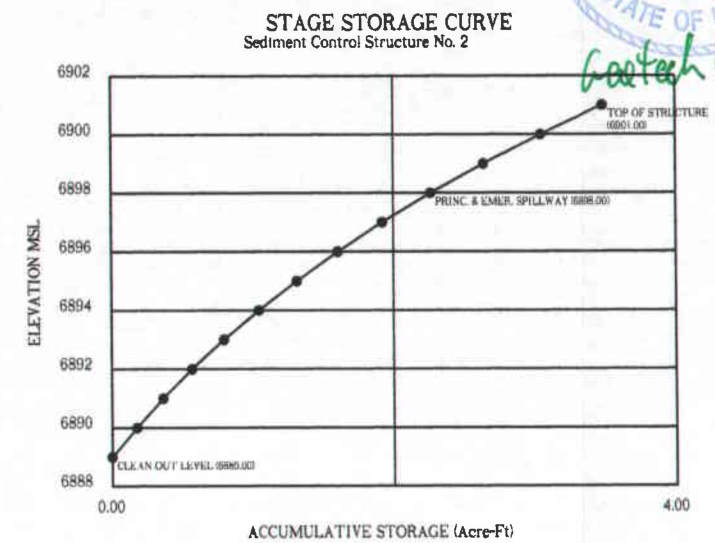
DRAWN BY:	CHECKED BY:
G. GROSSMAN	CRM/WES
DRAWING:	DATE:
5-28B	11/07/08
	SCALE:
	1" = 40'
JOB NUMBER:	SHEET
1400	

Figure
No. 12B



TYPICAL CROSS SECTION
Not to Scale





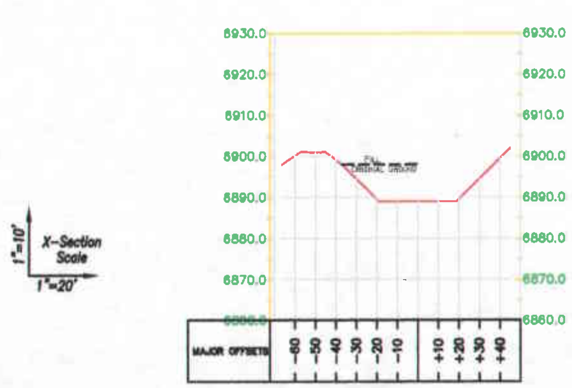
STORAGE VOLUME COMPUTATIONS

Sediment Control Structure No. 2

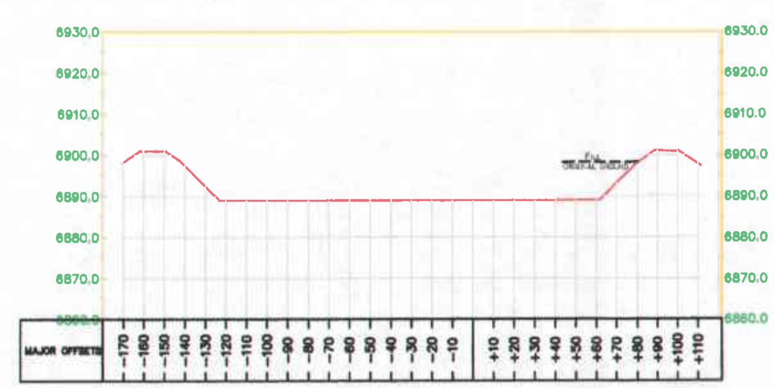
ELEV. (ft)	WIDTH (ft)	LENGTH (ft)	AREA (ac)	AVG. AREA (ac)	INTERVAL (ft)	STORAGE (ac-ft)	ACC. STORAGE (ac-ft)	STAGE INTERVAL (ft)
6889.00	NA	NA	0.0000					
6890.00	NA	NA	0.1770	0.1770	1.00	0.1770	0.1770	1.00
6891.00	NA	NA	0.1960	0.1865	1.00	0.1865	0.3635	2.00
6892.00	NA	NA	0.2160	0.2060	1.00	0.2060	0.5695	3.00
6893.00	NA	NA	0.2370	0.2265	1.00	0.2265	0.7960	4.00
6894.00	NA	NA	0.2580	0.2475	1.00	0.2475	1.0435	5.00
6895.00	NA	NA	0.2810	0.2695	1.00	0.2695	1.3130	6.00
6896.00	NA	NA	0.3040	0.2925	1.00	0.2925	1.6055	7.00
6897.00	NA	NA	0.3280	0.3160	1.00	0.3160	1.9215	8.00
6898.00	NA	NA	0.3570	0.3425	1.00	0.3425	2.2640	9.00
6899.00	NA	NA	0.3920	0.3745	1.00	0.3745	2.6385	10.00
6900.00	NA	NA	0.4250	0.4085	1.00	0.4085	3.0470	11.00
6901.00	NA	NA	0.4610	0.4430	1.00	0.4430	3.4900	12.00

Pond #2

Required Storage for 100 year, 24 event = 1.71 acre/ft



SL-1



SL-2

Alan D. Taylor 12-15-08
Geotech Only

REGISTERED PROFESSIONAL ENGINEER No. 183550 Alan D. Taylor STATE OF UTAH

Coal Hollow Project
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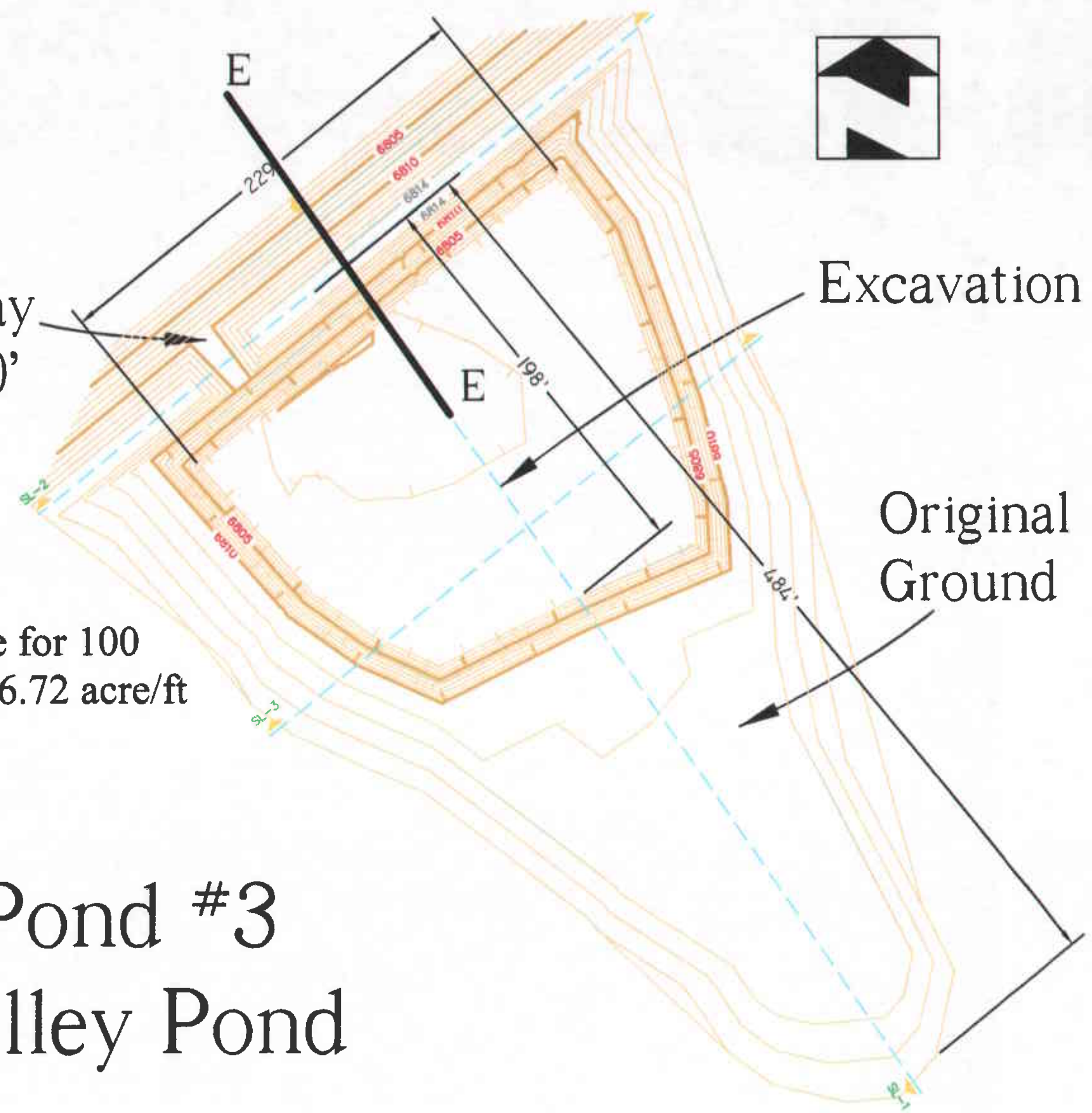
Registered Professional Engineer 275875-2202 CHRIS R. McCOURT State of Utah

SEDIMENT IMPOUNDMENT 2
DESIGN & DETAILS
COAL HOLLOW PROJECT
ALTON, UTAH
DRAWING: 5-29

REVISIONS	
DATE:	BY:

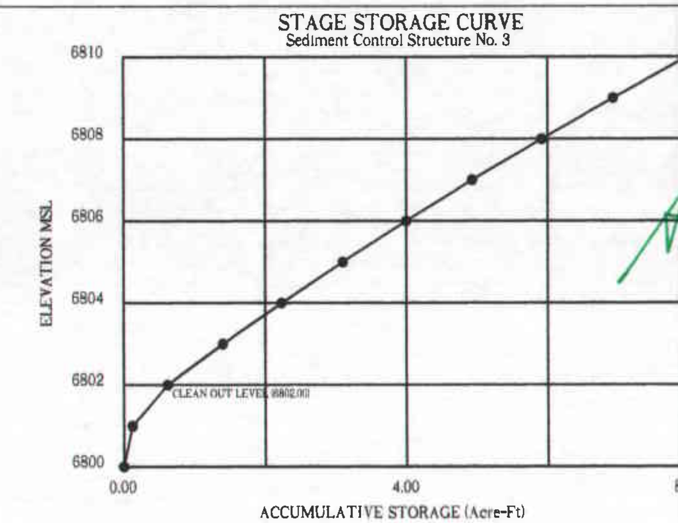
DRAWN BY: C. MCCOURT	CHECKED BY: CM
DRAWING: 5-29	DATE: 04/20/07
	SCALE: 1" = 80'
JOB NUMBER: 1400	SHEET

Figure No. 13



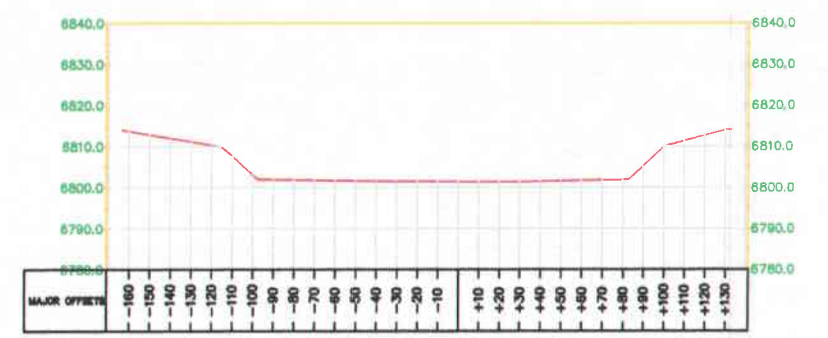
Required Storage for 100 year, 24 event = 6.72 acre/ft

Pond #3
Valley Pond



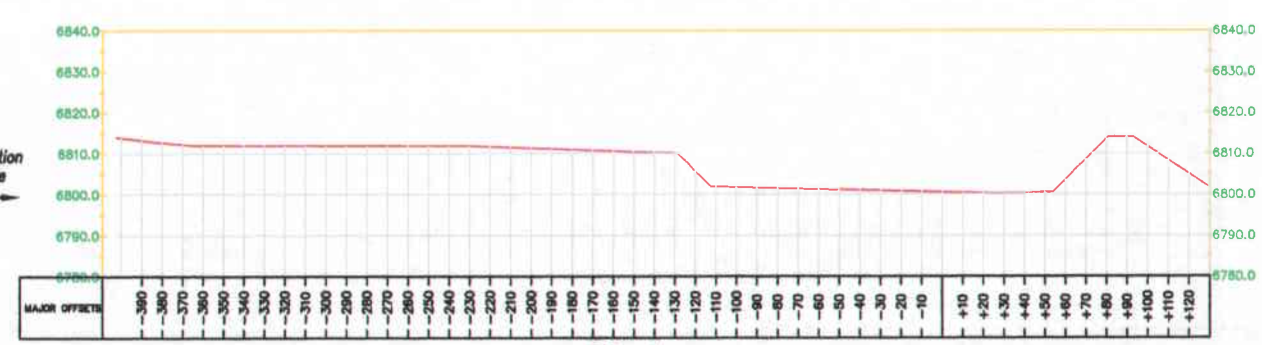
STORAGE VOLUME COMPUTATIONS
Sediment Control Structure No. 3

ELEV. (ft)	WIDTH (ft)	LENGTH (ft)	AREA (ac)	AVG. AREA (ac)	INTERVAL (ft)	STORAGE (ac-ft)	ACC. STORAGE (ac-ft)	STAGE INTERVAL (ft)
6800.00	NA	NA	0.0180					
6801.00	NA	NA	0.2320	0.1250	1.00	0.1250	0.1250	1.00
6802.00	NA	NA	0.7580	0.4950	1.00	0.4950	0.6200	2.00
6803.00	NA	NA	0.8110	0.7845	1.00	0.7845	1.4045	3.00
6804.00	NA	NA	0.8480	0.8295	1.00	0.8295	2.2340	4.00
6805.00	NA	NA	0.8840	0.8660	1.00	0.8660	3.1000	5.00
6806.00	NA	NA	0.9220	0.9030	1.00	0.9030	4.0030	6.00
6807.00	NA	NA	0.9580	0.9400	1.00	0.9400	4.9430	7.00
6808.00	NA	NA	0.9950	0.9765	1.00	0.9765	5.9195	8.00
6809.00	NA	NA	1.0400	1.0175	1.00	1.0175	6.9370	9.00
6810.00	NA	NA	1.0670	1.0535	1.00	1.0430	7.9800	10.00

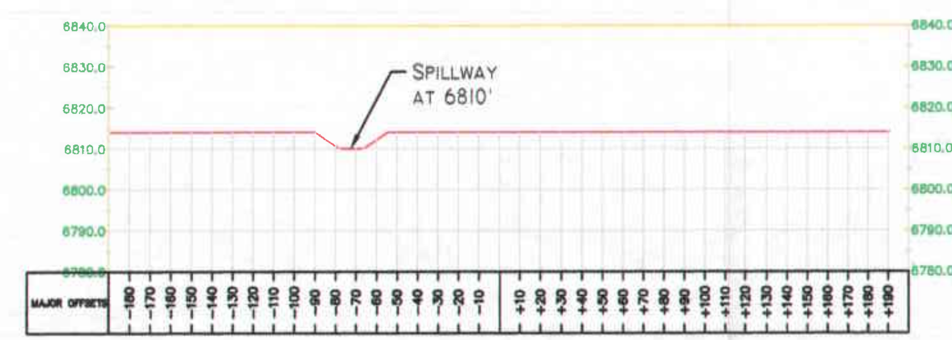


SL-3

X-Section Scale
1"=10'
1"=20'



SL-1



SL-2

Registered Professional Engineer No. 183550 Alanson Taylor State of Utah
Alanson R. Taylor 12-15-08
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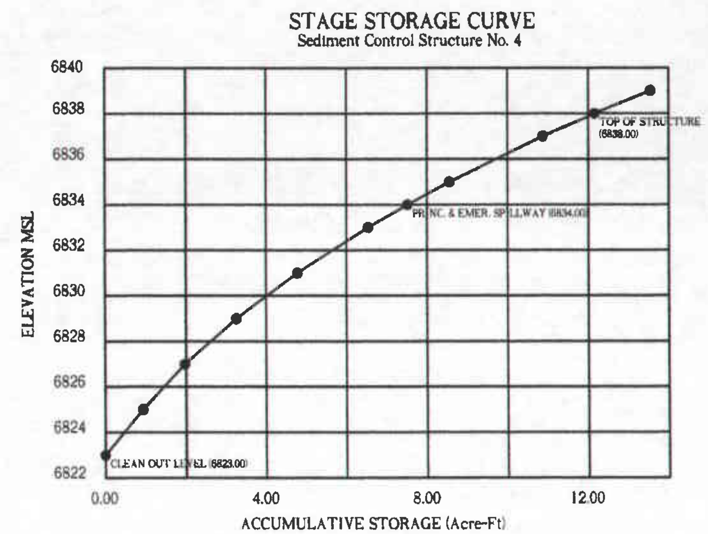
Registered Professional Engineer
275875-2202
CHRIS R. McCOURT
State of Utah

SEDIMENT IMPOUNDMENT 3
DESIGN & DETAILS
COAL HOLLOW PROJECT
ALTON, UTAH
DRAWING: 5-30

REVISIONS	
DATE:	BY:

DRAWN BY: C. MCCOURT	CHECKED BY: CM
DRAWING: 5-30	DATE: 12/18/06
	SCALE: 1" = 80'
JOB NUMBER: 1400	SHEET

Figure No. 14

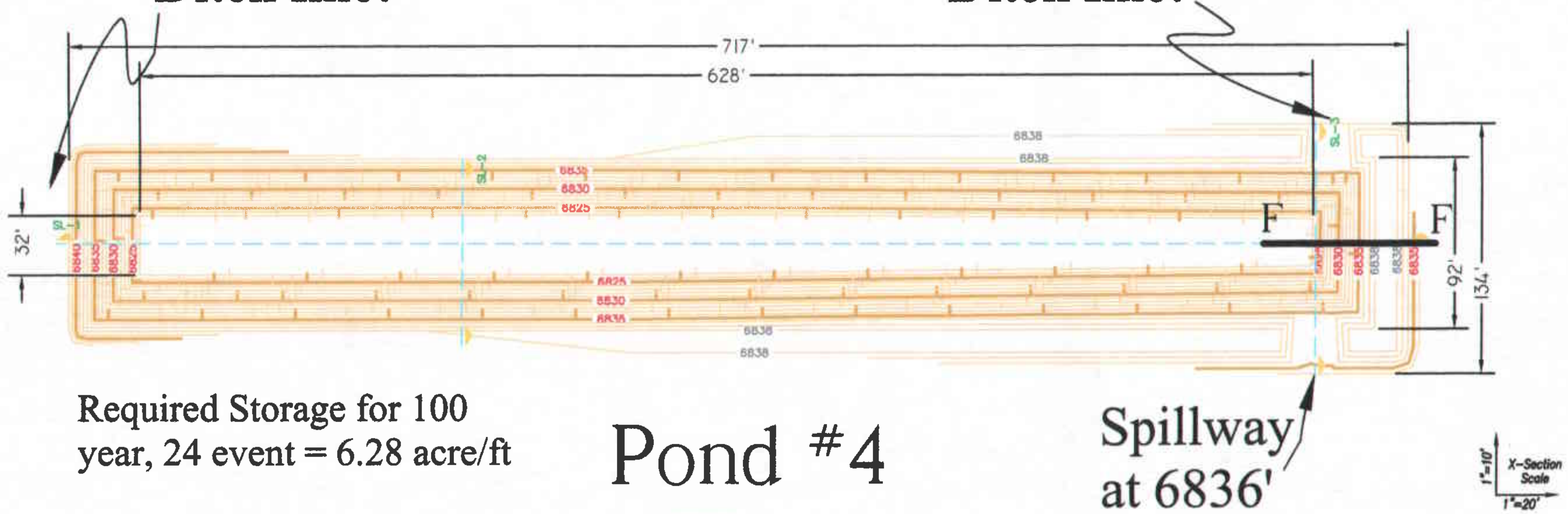


STORAGE VOLUME COMPUTATIONS

Sediment Control Structure No. 4

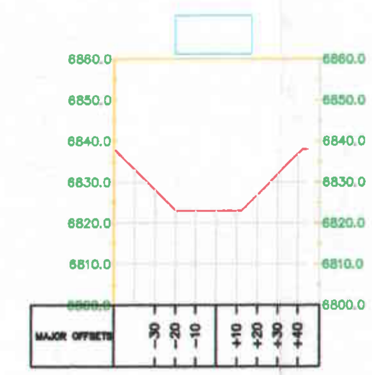
ELEV. (ft)	WIDTH (ft)	LENGTH (ft)	AREA (ac)	AVG. AREA (ac)	INTERVAL (ft)	STORAGE (ac-ft)	ACC. STORAGE (ac-ft)	STAGE INTERVAL (ft)
6823.00	NA	NA	0.0000					
6825.00	NA	NA	0.4660	0.4660	2.00	0.9320	0.9320	2.00
6827.00	NA	NA	0.5810	0.5235	2.00	1.0470	1.9790	4.00
6829.00	NA	NA	0.6990	0.6400	2.00	1.2800	3.2590	6.00
6831.00	NA	NA	0.8200	0.7595	2.00	1.5190	4.7780	8.00
6833.00	NA	NA	0.9430	0.8815	2.00	1.7630	6.5410	10.00
6834.00	NA	NA	1.0090	0.9760	1.00	0.9760	7.5170	11.00
6835.00	NA	NA	1.0750	1.0420	1.00	1.0420	8.3590	12.00
6837.00	NA	NA	1.2400	1.1575	2.00	2.3150	10.8740	14.00
6838.00	NA	NA	1.3370	1.2885	1.00	1.2885	12.1625	15.00

Alan D. Taylor 12-15-08
Geo Tech Only

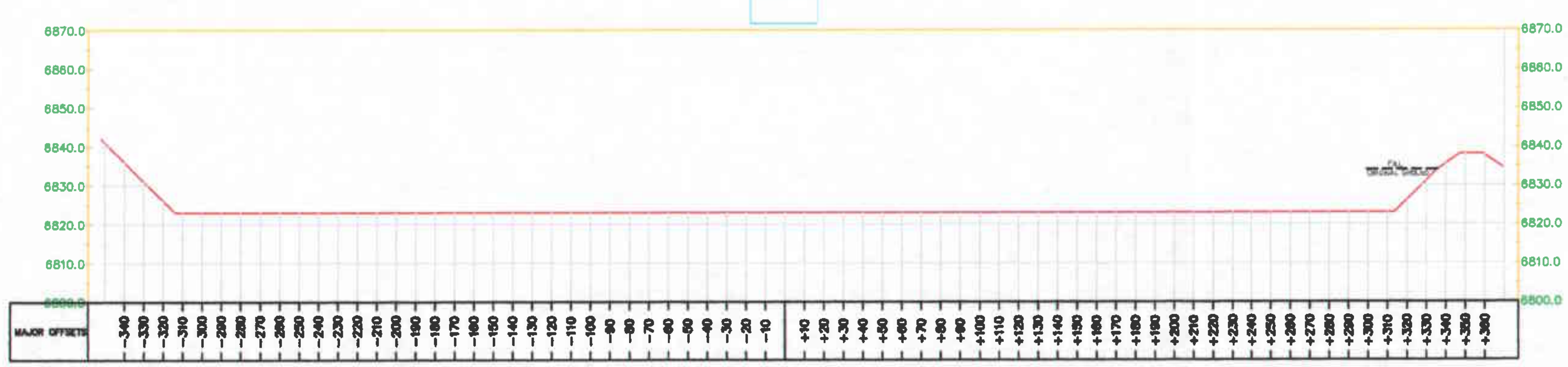


Required Storage for 100 year, 24 event = 6.28 acre/ft

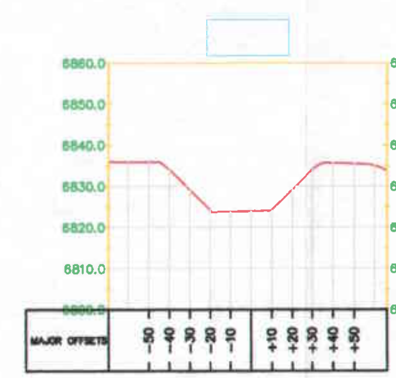
Pond #4



SL-2



SL-1



SL-3

DRAWN BY:	CHECKED BY:
C. MCCOURT	CM
DRAWING:	DATE:
5-31	04/20/07
	SCALE: 1" = 80'
JOB NUMBER: 1400	SHEET

REVISIONS

DATE:	BY:

SEDIMENT IMPOUNDMENT 4

DESIGN & DETAILS

COAL HOLLOW PROJECT
ALTON, UTAH

DRAWING: 5-31

Registered Professional Engineer 275875-2202 CHRIS R. McCOURT State of Utah

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615 North, 400 East
P.O. Box 1230
Huntington, Utah 84528
Phone (435)687-5310
Fax (435)687-5311

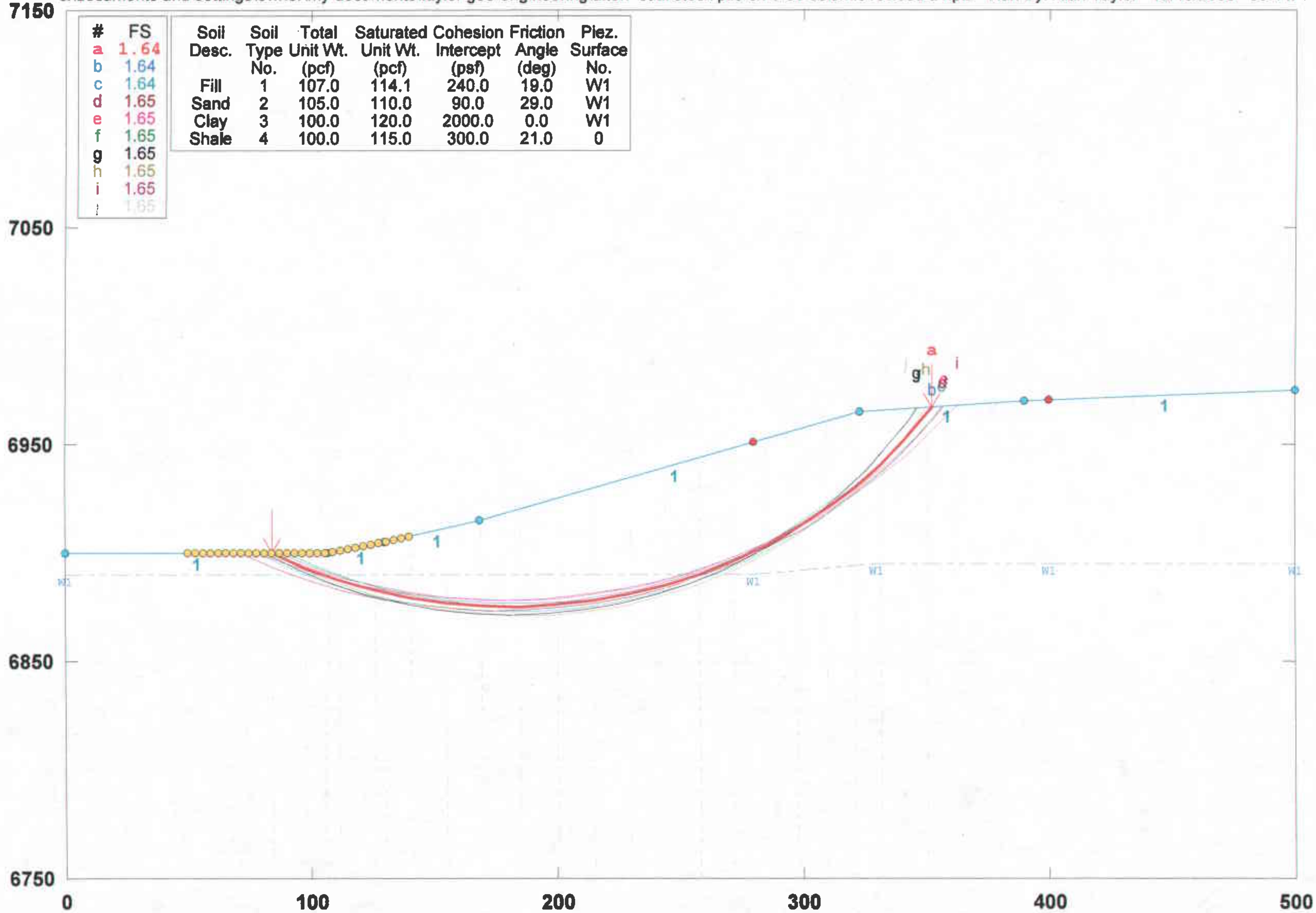
Figure No. 15

APPENDIX E

OUPTUT FILES OF STATIC, PSEUDO-STATIC and RAPID DRAWDOWN SLOPE STABILITY ANALYSES

Alton Coal Pile Line A1-A1 - Static

c:\documents and settings\owner\my documents\taylor geo-engineering\alton coal stock pile ch-5-98 seismic revised a1.pl2 Run By: Alan Taylor 12/13/2008 09:44PM



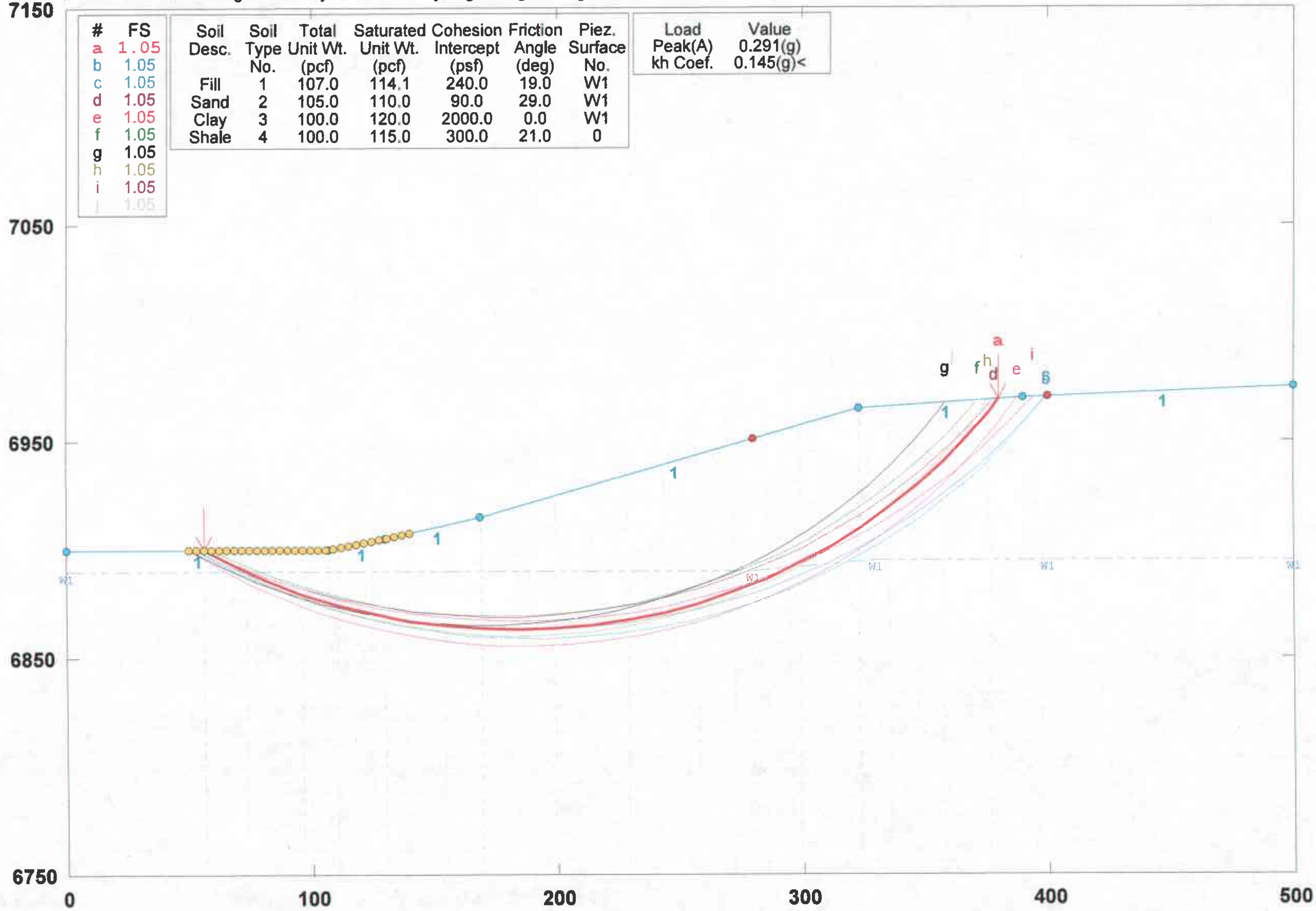
GSTABL7 v.2 FSmin=1.64
Safety Factors Are Calculated By The Modified Bishop Method

GSTABL7

Figure No. 16

Alton Coal Pile Line A1-A1 - Seismic

c:\documents and settings\owner\my documents\taylor geo-engineering\alton coal stock pile ch-5-98 seismic revised a1.pl2 Run By: Alan Taylor 12/13/2008 09:42PM



GSTABL7 v.2 FSmin=1.05

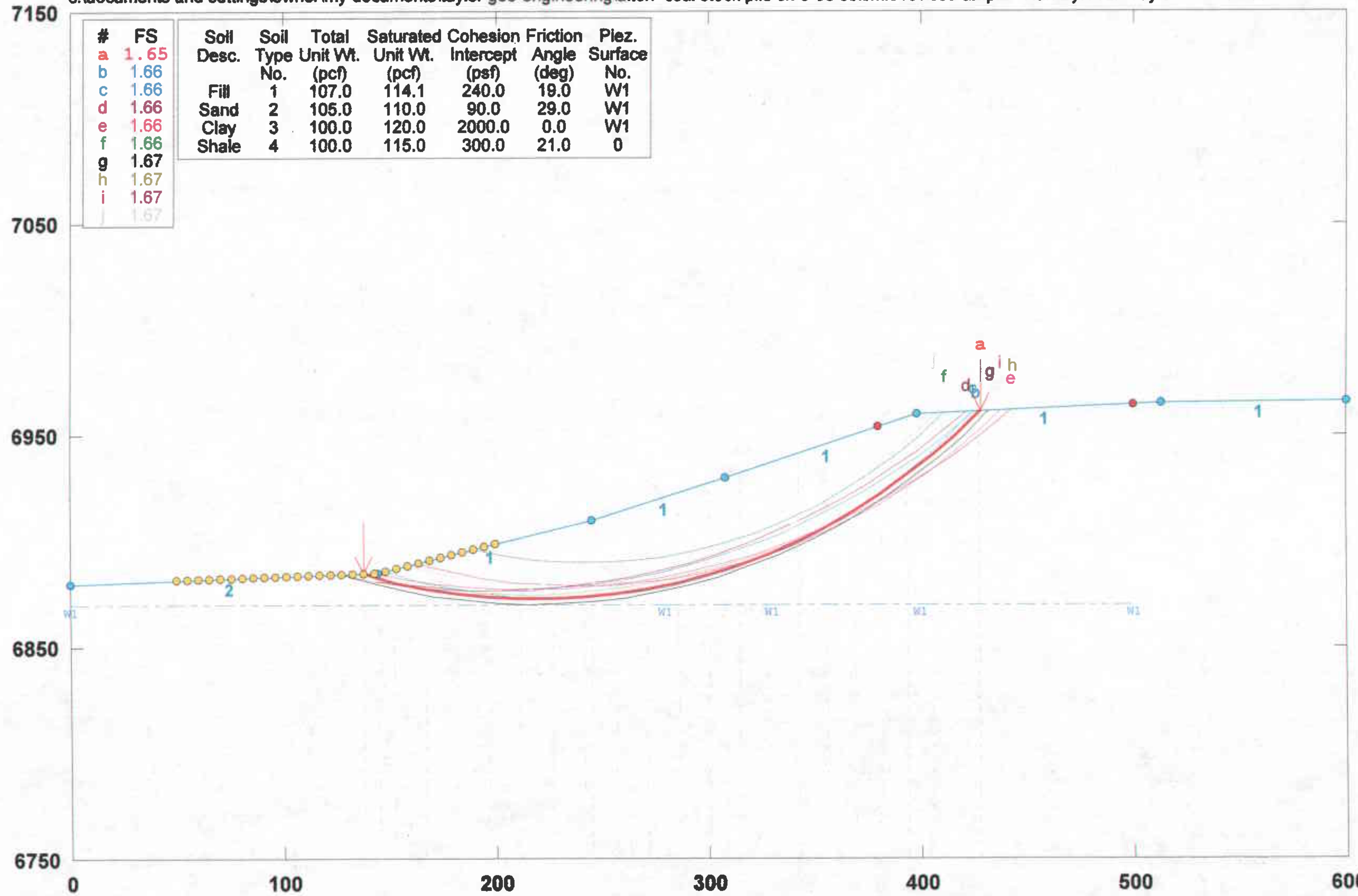
Safety Factors Are Calculated By The Modified Bishop Method

Figure No. 17

GSTABL7

Alton Coal Pile Line A2-A2 - Static

c:\documents and settings\owner\my documents\taylor geo-engineering\alton coal stock pile ch-5-98 seismic revised a2.pl2 Run By: Alan Taylor 12/13/2008 09:37PM

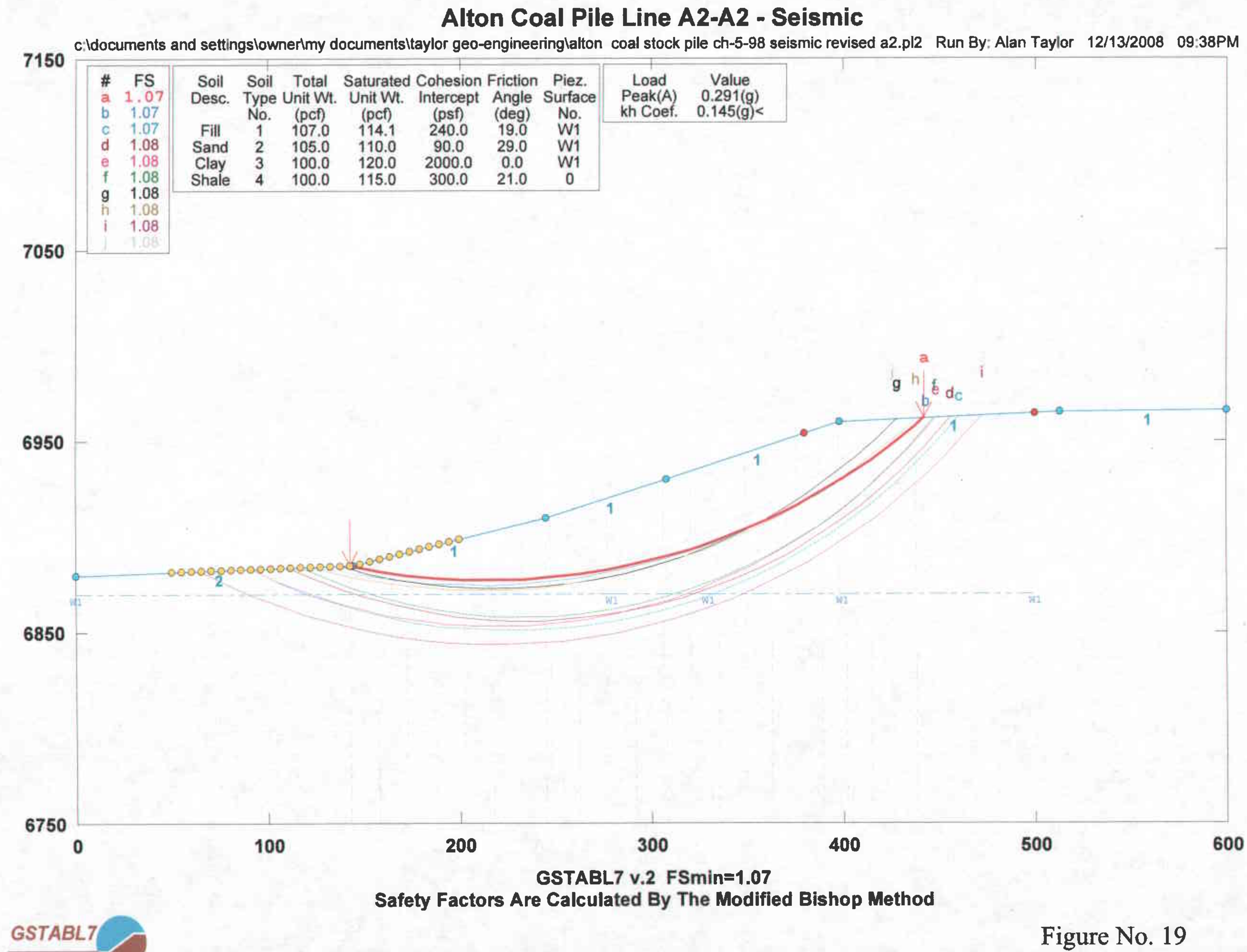


GSTABL7 v.2 FSmin=1.65

Safety Factors Are Calculated By The Modified Bishop Method

GSTABL7

Figure No. 18


Alton Coal Pile Line A2-A2 - Seismic
c:\documents and settings\owner\my documents\taylor geo-engineering\alton coal stock pile ch-5-98 seismic revised a2.pl2 Run By: Alan Taylor 12/13/2008 09:38PM

#	FS
a	1.07
b	1.07
c	1.07
d	1.08
e	1.08
f	1.08
g	1.08
h	1.08
i	1.08
j	1.08

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
Fill	1	107.0	114.1	240.0	19.0	W1
Sand	2	105.0	110.0	90.0	29.0	W1
Clay	3	100.0	120.0	2000.0	0.0	W1
Shale	4	100.0	115.0	300.0	21.0	0

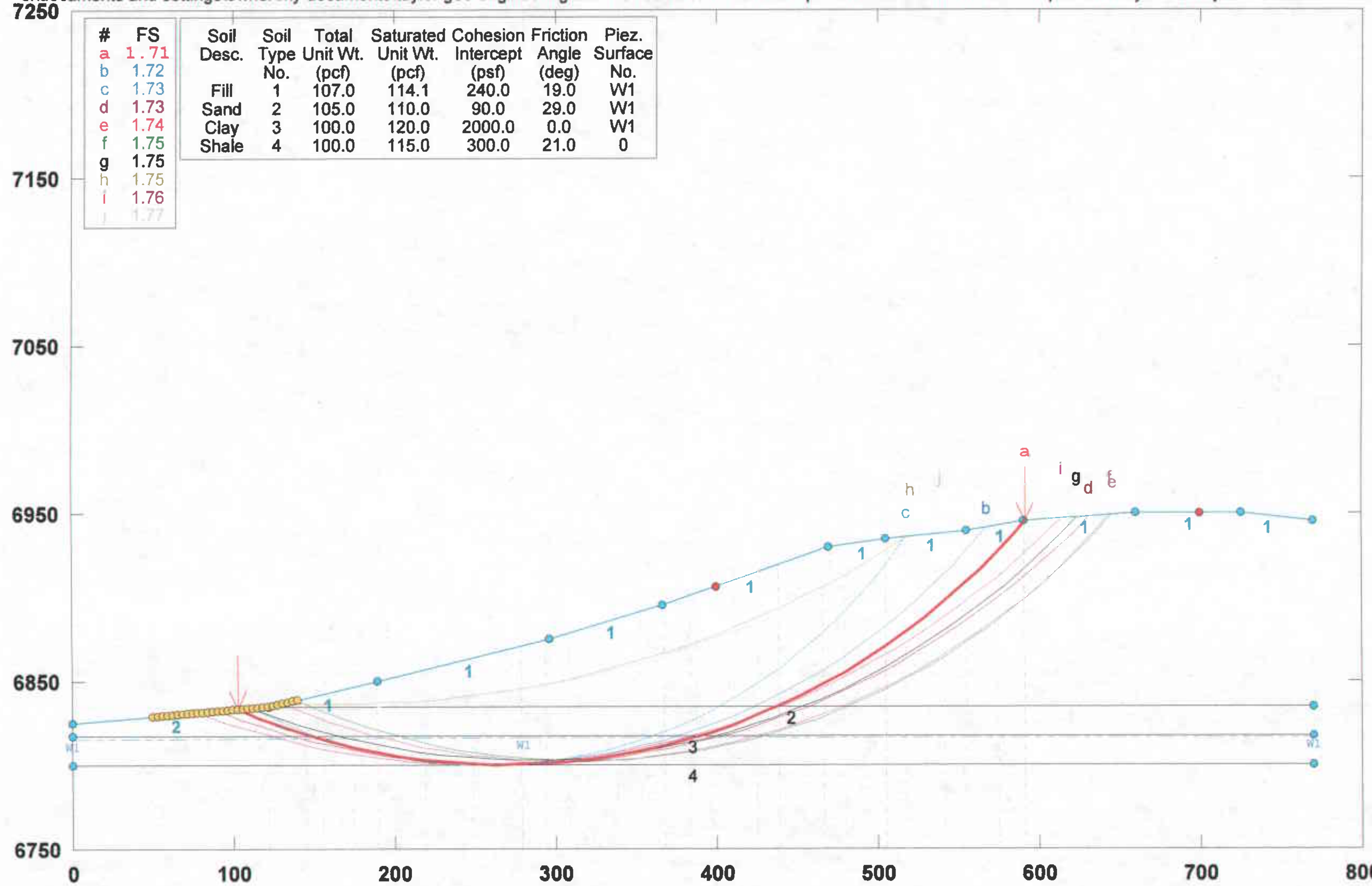
Load	Value
Peak(A)	0.291(g)
kh Coef.	0.145(g)<

7150
7050
6950
6850
6750
0
100
200
300
400
500
600
GSTABL7 v.2 FSmin=1.07
Safety Factors Are Calculated By The Modified Bishop Method
GSTABL7

Figure No. 19

Alton Coal Pile Line B1-B1 - Static

c:\documents and settings\owner\my documents\taylor geo-engineering\alton revised\alton coal stock pile ch-5-98 seismic revised b1.pl2 Run By: Alan Taylor 12/13/2008 09:34PM

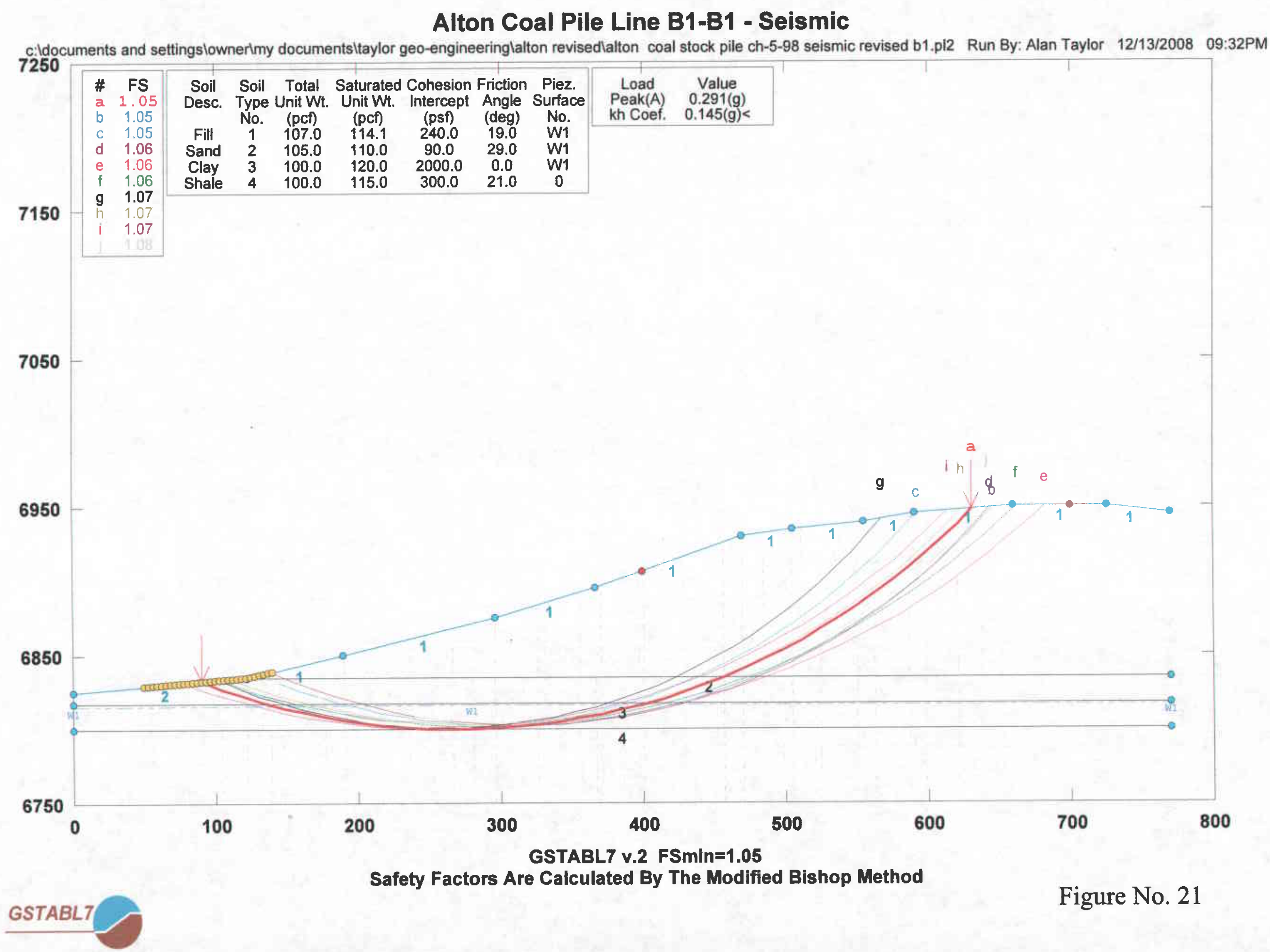


GSTABL7 v.2 FSmin=1.71

Safety Factors Are Calculated By The Modified Bishop Method

GSTABL7

Figure No. 20



Alton Coal Pile Line B1-B1 - Seismic
c:\documents and settings\owner\my documents\taylor geo-engineering\alton revised\alton coal stock pile ch-5-98 seismic revised b1.pl2 Run By: Alan Taylor 12/13/2008 09:32PM
FS
a 1.05
b 1.05
c 1.05
d 1.06
e 1.06
f 1.06
g 1.07
h 1.07
i 1.07
j 1.08
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
Fill 1 107.0 114.1 240.0 19.0 W1
Sand 2 105.0 110.0 90.0 29.0 W1
Clay 3 100.0 120.0 2000.0 0.0 W1
Shale 4 100.0 115.0 300.0 21.0 0
Load Value
Peak(A) 0.291(g)
kh Coef. 0.145(g)<
7250
7150
7050
6950
6850
6750
0
100
200
300
400
500
600
700
800
GSTABL7 v.2 FSmin=1.05
Safety Factors Are Calculated By The Modified Bishop Method
GSTABL7

Figure No. 21

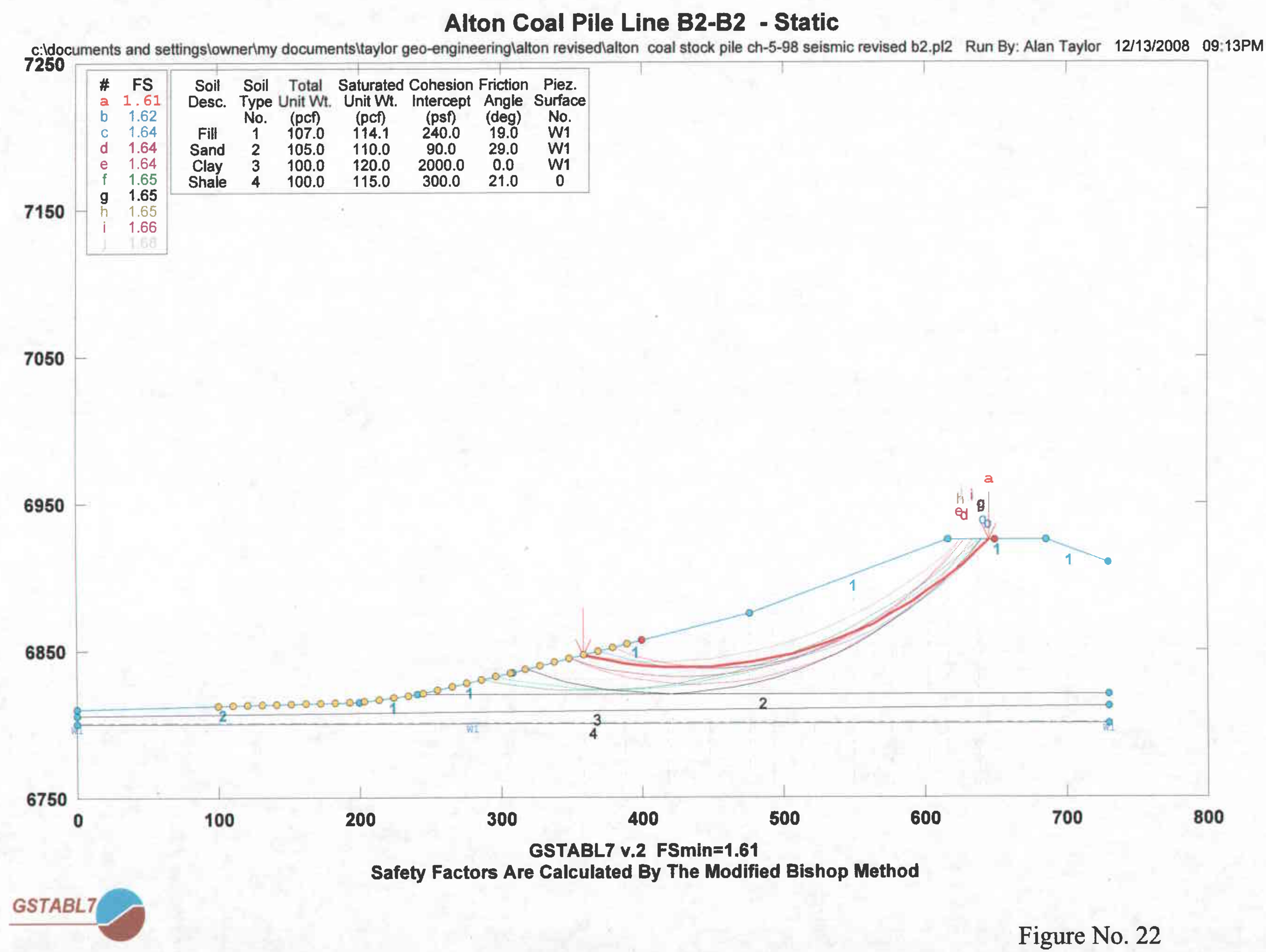
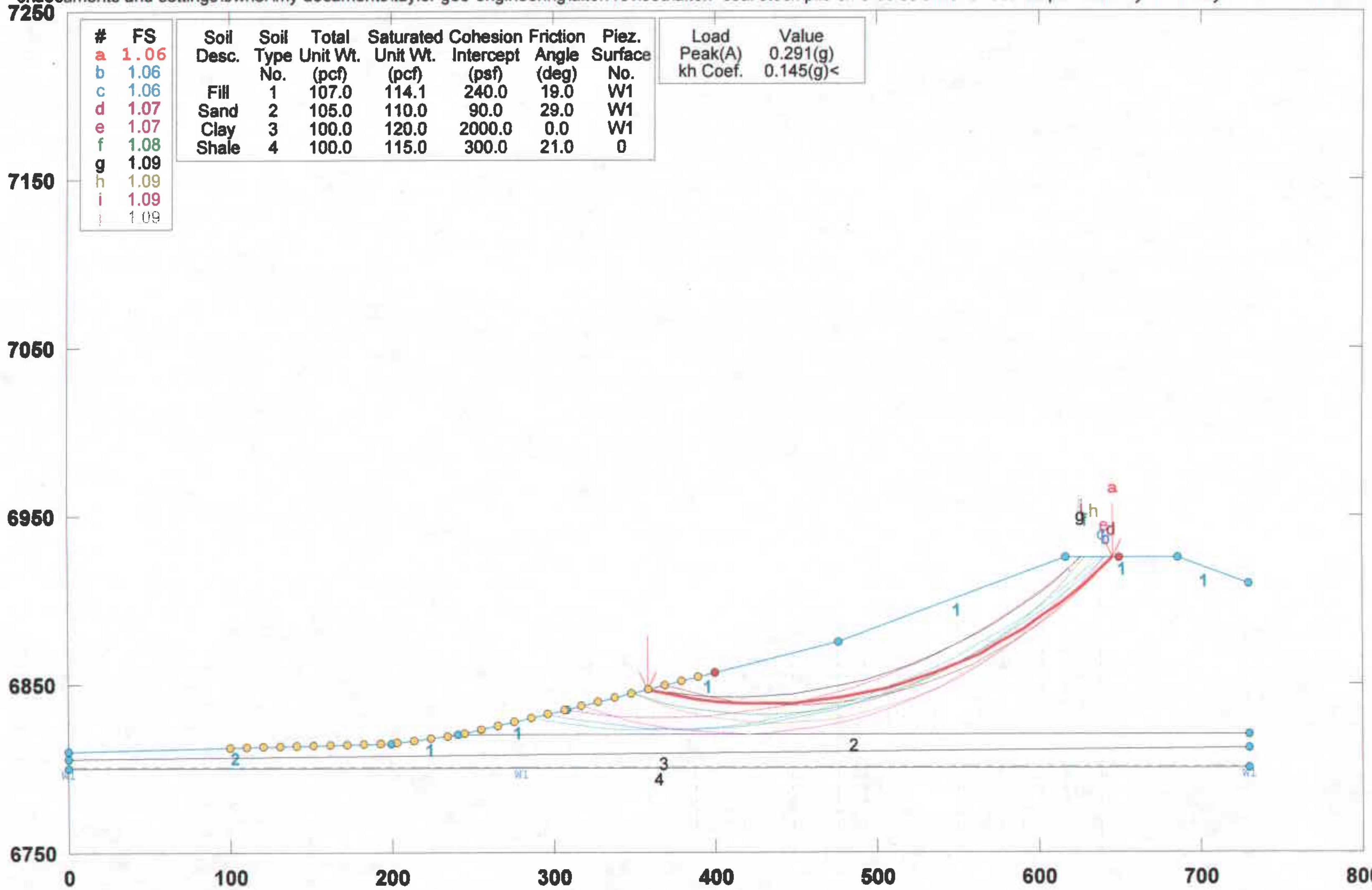

Alton Coal Pile Line B2-B2 - Static
c:\documents and settings\owner\my documents\taylor geo-engineering\alton revised\alton coal stock pile ch-5-98 seismic revised b2.pl2 Run By: Alan Taylor 12/13/2008 09:13PM
FS
a 1.61
b 1.62
c 1.64
d 1.64
e 1.64
f 1.65
g 1.65
h 1.65
i 1.66
j 1.68
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
Fill 1 107.0 114.1 240.0 19.0 W1
Sand 2 105.0 110.0 90.0 29.0 W1
Clay 3 100.0 120.0 2000.0 0.0 W1
Shale 4 100.0 115.0 300.0 21.0 0
7250
7150
7050
6950
6850
6750
0
100
200
300
400
500
600
700
800
GSTABL7 v.2 FSmin=1.61
Safety Factors Are Calculated By The Modified Bishop Method
GSTABL7

Figure No. 22

Alton Coal Pile Line B2-B2 - Seismic

c:\documents and settings\owner\my documents\taylor geo-engineering\alton revised\alton coal stock pile ch-5-98 seismic revised b2.pl2 Run By: Alan Taylor 12/13/2008 09:16PM



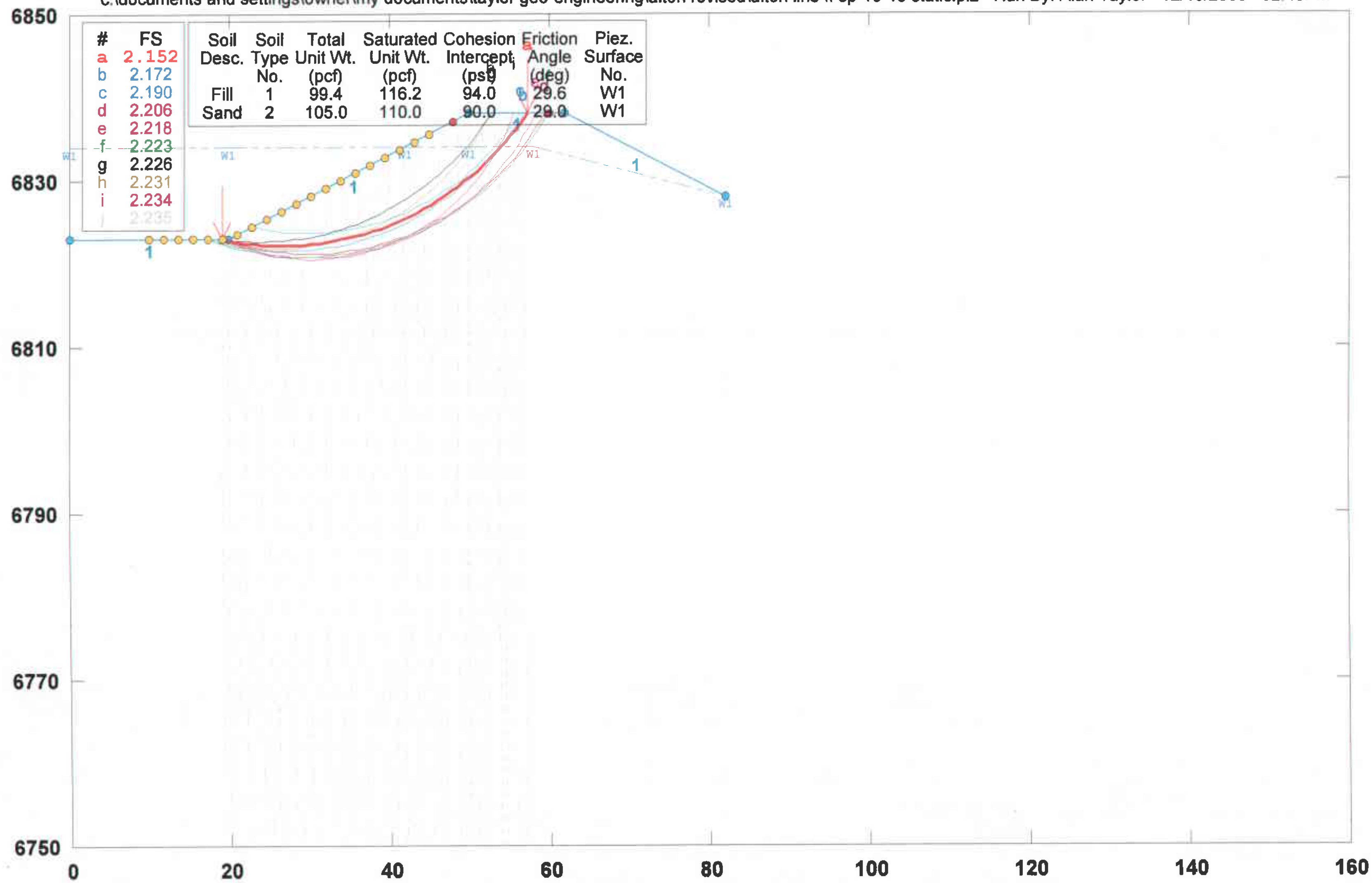
GSTABL7 v.2 FSmin=1.06

Safety Factors Are Calculated By The Modified Bishop Method

Figure No. 23

Alton Coal Hollow Sedimentation Pond 4: Line FF, Soil SP-16-13 - Static

c:\documents and settings\owner\my documents\taylor geo-engineering\alton revised\alton line ff sp-16-13 static.pl2 Run By: Alan Taylor 12/15/2008 02:48PM



GSTABL7 v.2 FSmin=2.152

Safety Factors Are Calculated By The Modified Bishop Method

GSTABL7

Figure No. 24

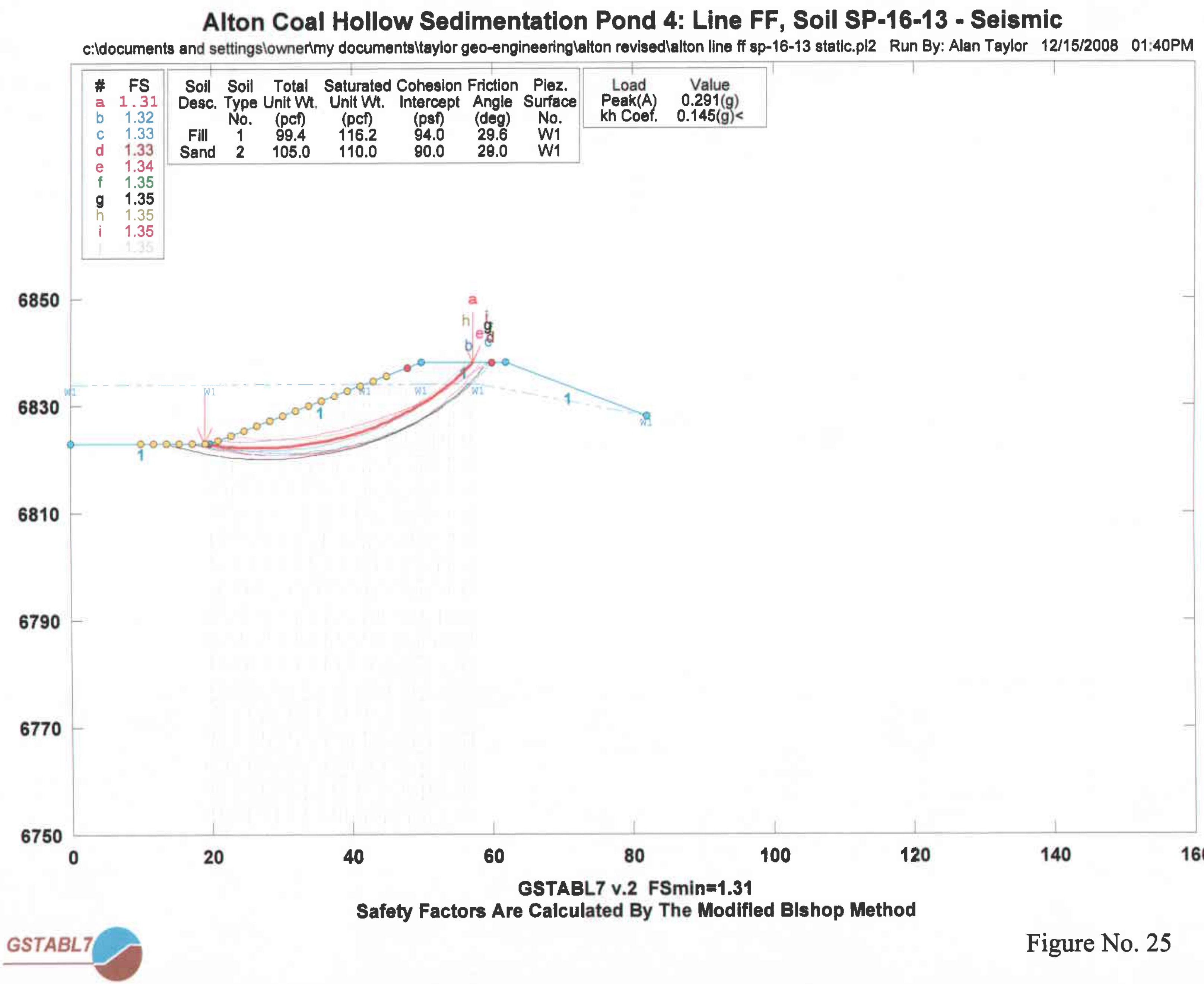
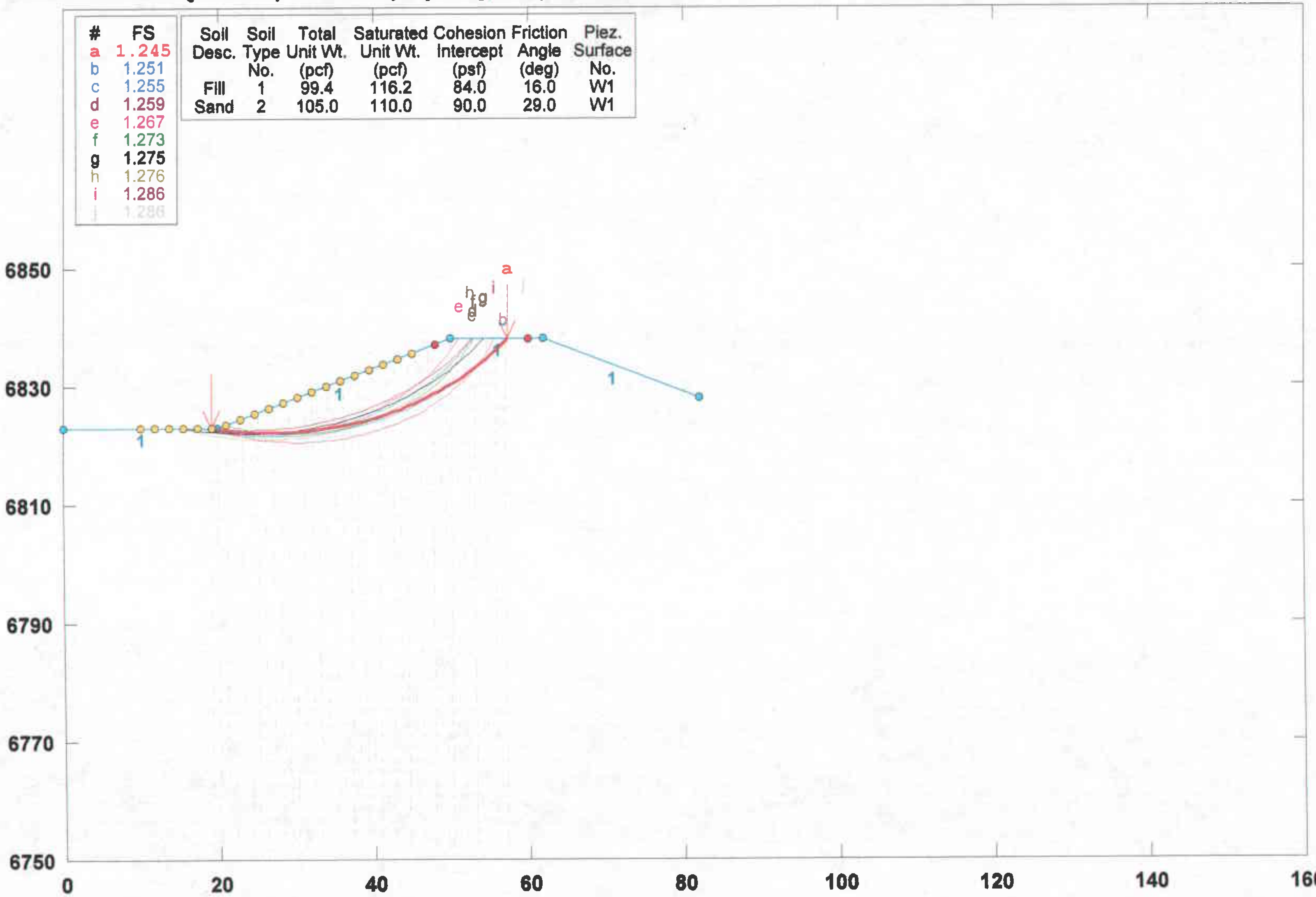

Alton Coal Hollow Sedimentation Pond 4: Line FF, Soil SP-16-13 - Seismic
c:\documents and settings\owner\my documents\taylor geo-engineering\alton revised\alton line ff sp-16-13 static.pl2 Run By: Alan Taylor 12/15/2008 01:40PM
FS
a 1.31
b 1.32
c 1.33
d 1.33
e 1.34
f 1.35
g 1.35
h 1.35
i 1.35
j 1.35
Soil Desc. | Soil Type No. | Total Unit Wt. (pcf) | Saturated Unit Wt. (pcf) | Cohesion Intercept (psf) | Friction Angle (deg) | Piez. Surface No.
Fill 1 99.4 116.2 94.0 29.6 W1
Sand 2 105.0 110.0 90.0 28.0 W1
Load Value
Peak(A) 0.291(g)
kh Coef. 0.145(g)<
6850
6830
6810
6790
6770
6750
0
20
40
60
80
100
120
140
160
GSTABL7 v.2 FSmin=1.31
Safety Factors Are Calculated By The Modified Bishop Method
GSTABL7

Figure No. 25

Alton Coal Hollow Sedimentation Pond 4: Line FF, Soil SP-16-13 - Rapid Drawdown

c:\documents and settings\owner\my documents\taylor geo-engineering\alton revised\alton line ff sp-16-13 rapid drawdown stage 1.pl2 Run By: Alan Taylor 12/15/2008 01:31PM



GSTABL7 v.2 FSmin=1.245

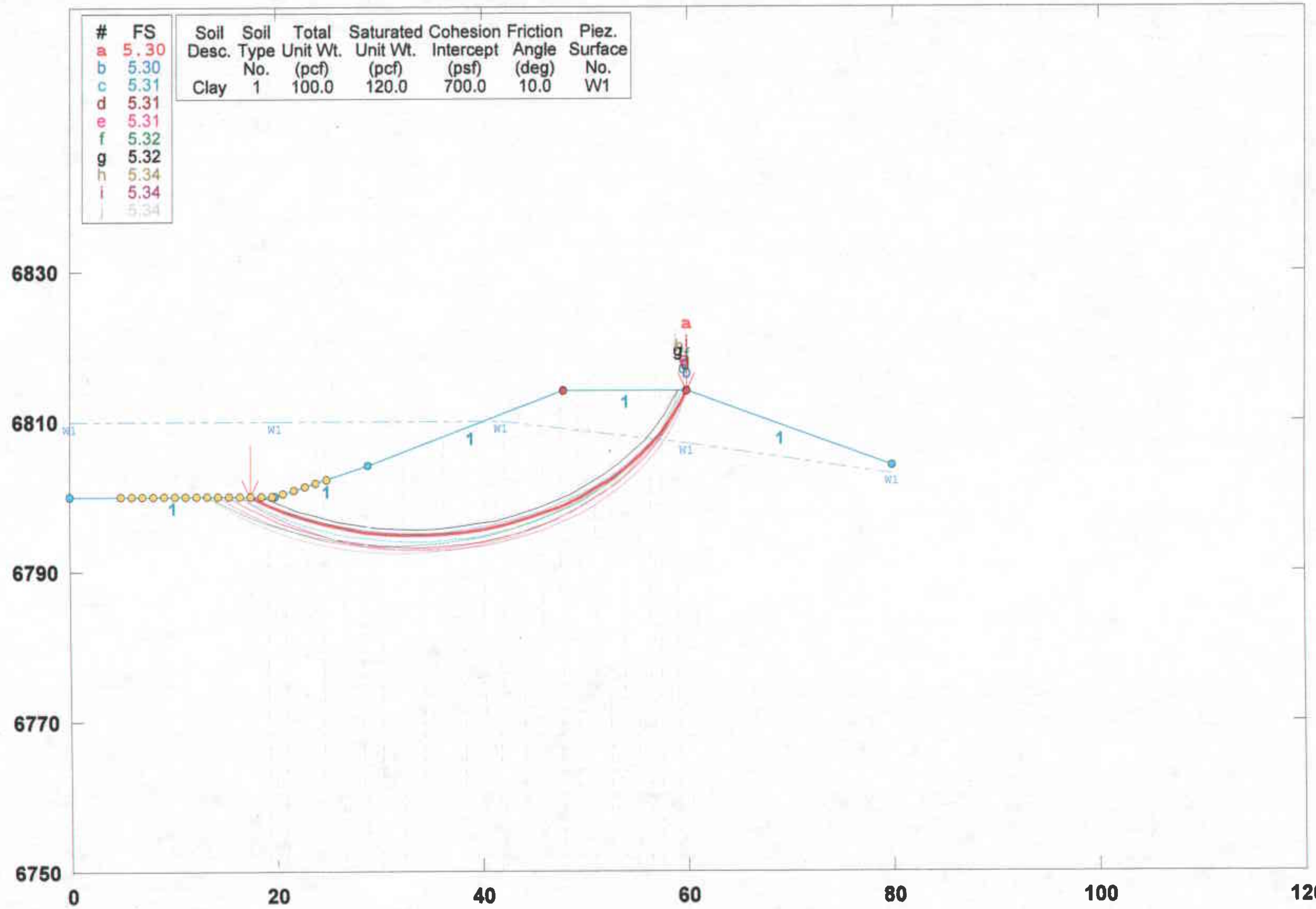
Safety Factors Are Calculated By The Modified Bishop Method

GSTABL7

Figure No. 26

Alton Coal Hollow Sedimentation Pond 3: Line E-E, Soil GT-5 - Static

f:\alton line ee gt-5.pl2 Run By: Alan Taylor 12/15/2008 01:45PM



GSTABL7 v.2 FSmin=5.30

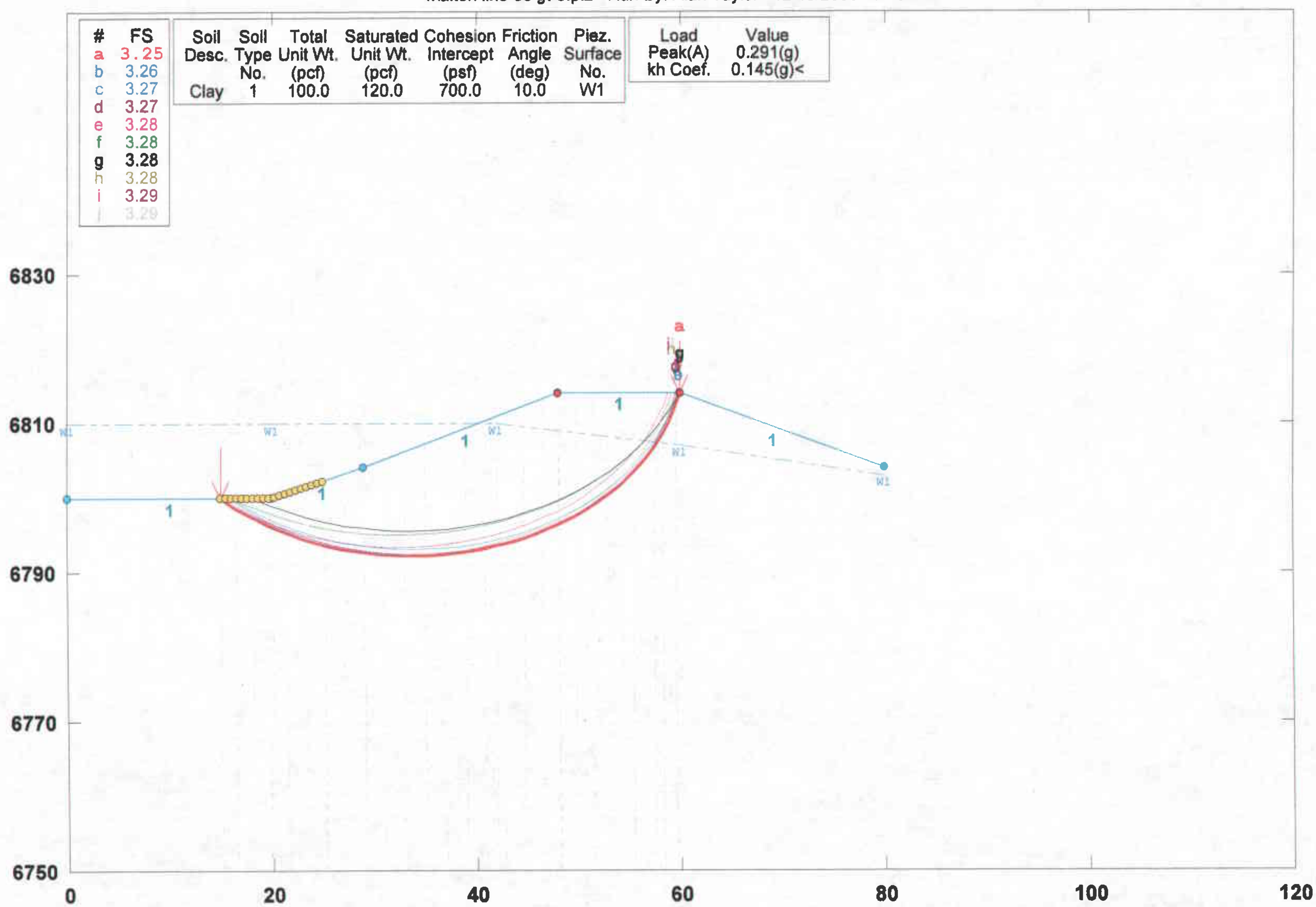
Safety Factors Are Calculated By The Modified Bishop Method

GSTABL7

Figure No. 27

Alton Coal Hollow Sedimentation Pond 3: Line E-E, Soil GT-5 - Seismic

f:\alton line ee gt-5.pl2 Run By: Alan Taylor 12/15/2008 01:50PM



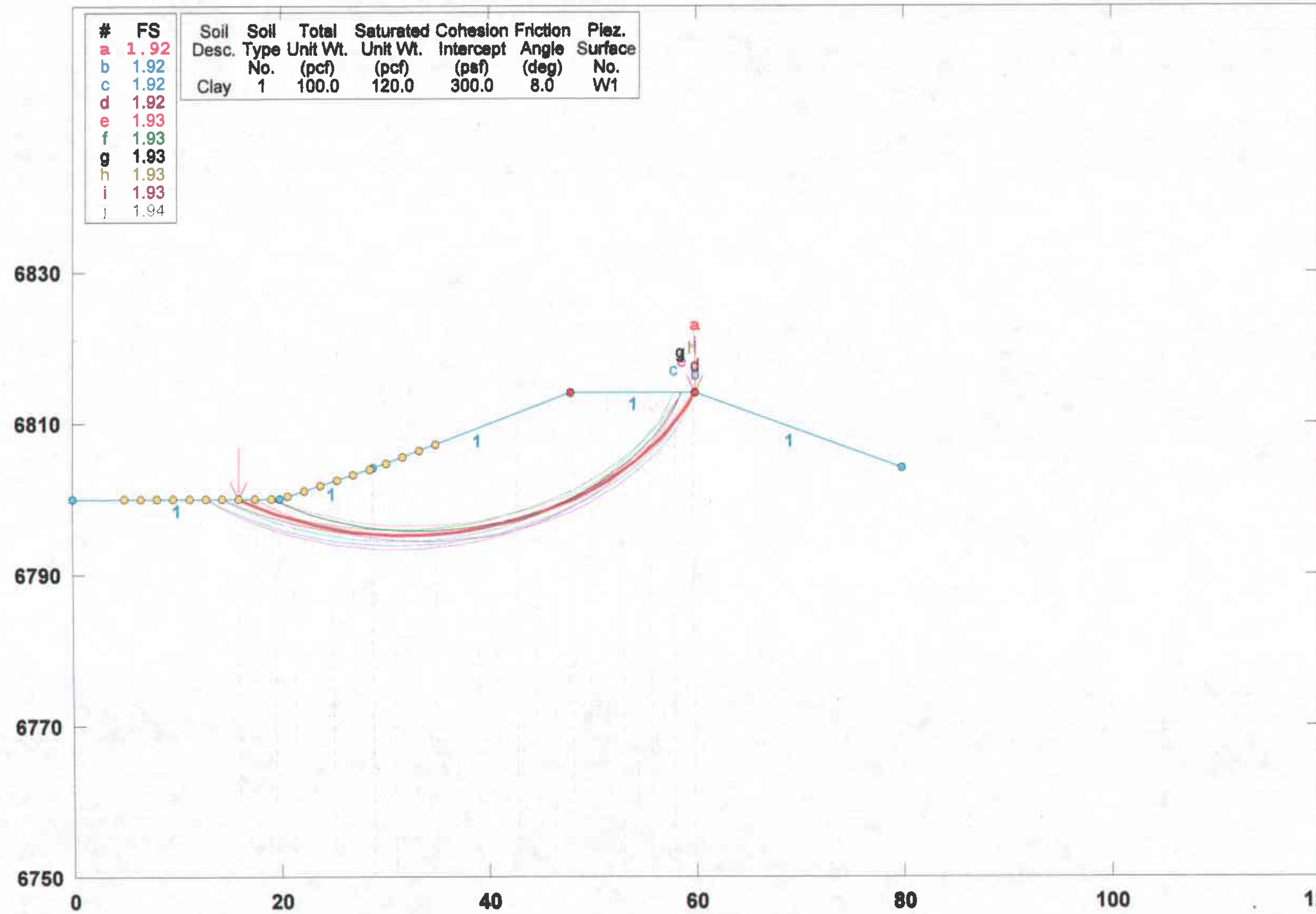
GSTABL7 v.2 FSmin=3.25

Safety Factors Are Calculated By The Modified Bishop Method

Figure No. 28

Alton Coal Hollow Sedimentation Pond 3: Line E-E, Soil GT-5 - Rapid Drawdown

f:\line ee rapid drawdown.pl2 Run By: Alan Taylor 12/15/2008 02:01PM



GSTABL7 v.2 FSmin=1.92

Safety Factors Are Calculated By The Modified Bishop Method

Figure No. 29

APPENDIX E-1

OUPTUT FILES OF STATIC AND PSEUDO-STATIC SLOPE STABILITY ANALYSES

LINE A1-A1

***** GSTABL7 *****

** GSTABL7 by Garry H. Gregory, P.E. **
** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **

****

SLOPE STABILITY ANALYSIS SYSTEM
Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.

****

```
    Analysis Run Date:        12/13/2008
    Time of Run:              09:44PM
    Run By:                   Alan Taylor
    Input Data Filename:      C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engi
neering\alton  coal stock pile ch-5-98 seismic revised a1.in
    Output Filename:          C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engi
neering\alton  coal stock pile ch-5-98 seismic revised a1.OUT
    Unit System:              English
    Plotted Output Filename:  C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engi
neering\alton  coal stock pile ch-5-98 seismic revised a1.PLT
    PROBLEM DESCRIPTION:  Alton Coal Pile Line A1-A1 - Static
    BOUNDARY COORDINATES
        6 Top   Boundaries
        6 Total Boundaries
```

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	6900.00	107.00	6900.00	1
2	107.00	6900.00	130.00	6905.00	1
3	130.00	6905.00	169.00	6915.00	1
4	169.00	6915.00	323.00	6965.00	1
5	323.00	6965.00	390.00	6970.00	1
6	390.00	6970.00	500.00	6975.00	1

```
    User Specified Y-Origin =      6750.00(ft)
    Default X-Plus Value = 0.00(ft)
    Default Y-Plus Value = 0.00(ft)
   ISOTROPIC SOIL PARAMETERS
     4 Type(s) of Soil
```

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	107.0	114.1	240.0	19.0	0.00	0.0	1
2	105.0	110.0	90.0	29.0	0.00	0.0	1
3	100.0	120.0	2000.0	0.0	0.00	0.0	1
4	100.0	115.0	300.0	21.0	0.00	0.0	0

```
    1 PIEZOMETRIC SURFACE(S) SPECIFIED
    Unit Weight of Water =  62.40 (pcf)
    Piezometric Surface No.  1 Specified by  5 Coordinate Points
    Pore Pressure Inclination Factor =  0.50
```

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	6890.00
2	280.00	6890.00
3	330.00	6895.00
4	400.00	6895.00
5	500.00	6895.00

```
    Specified Peak Ground Acceleration Coefficient (A) =   0.291(g)
    Specified Horizontal Earthquake Coefficient (kh) =   0.145(g)
    Specified Vertical Earthquake Coefficient (kv) =   0.000(g)
    Specified Seismic Pore-Pressure Factor =   0.000
    EARTHQUAKE DATA HAS BEEN SUPPRESSED
    A Critical Failure Surface Searching Method, Using A Random
    Technique For Generating Circular Surfaces, Has Been Specified.
     900 Trial Surfaces Have Been Generated.
      30 Surface(s) Initiate(s) From Each Of    30 Points Equally Spaced
    Along The Ground Surface Between  X =   50.00(ft)
                                    and  X = 140.00(ft)
```

Each Surface Terminates Between X = 280.00(ft)
and X = 400.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 6700.00(ft)
15.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Evaluated. They Are
Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 900
Number of Trial Surfaces With Valid FS = 900
Statistical Data On All Valid FS Values:
FS Max = 3.216 FS Min = 1.643 FS Ave = 1.815
Standard Deviation = 0.138 Coefficient of Variation = 7.58 %
Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	84.138	6900.000
2	97.575	6893.333
3	111.464	6887.668
4	125.732	6883.039
5	140.300	6879.467
6	155.092	6876.974
7	170.026	6875.573
8	185.023	6875.271
9	200.002	6876.069
10	214.882	6877.964
11	229.582	6880.945
12	244.025	6884.996
13	258.131	6890.096
14	271.826	6896.216
15	285.035	6903.325
16	297.686	6911.383
17	309.713	6920.347
18	321.050	6930.169
19	331.635	6940.797
20	341.413	6952.172
21	350.330	6964.233
22	352.190	6967.178

Circle Center At X = 181.615 ; Y = 7079.424 ; and Radius = 204.193
Factor of Safety
*** 1.643 ***
Individual data on the 27 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	13.4	4793.4	0.0	0.0	0.	0.	0.0	0.0	0.0
2	8.2	7286.9	0.0	0.0	0.	0.	0.0	0.0	0.0
3	1.3	1377.6	0.0	21.6	0.	0.	0.0	0.0	0.0
4	4.5	5732.4	0.0	427.6	0.	0.	0.0	0.0	0.0
5	14.3	26679.8	0.0	4349.1	0.	0.	0.0	0.0	0.0
6	4.3	10283.9	0.0	2052.4	0.	0.	0.0	0.0	0.0
7	10.3	28882.6	0.0	6134.6	0.	0.	0.0	0.0	0.0
8	14.8	50801.6	0.0	11025.4	0.	0.	0.0	0.0	0.0
9	13.9	56257.3	0.0	11923.1	0.	0.	0.0	0.0	0.0
10	1.0	4446.7	0.0	924.7	0.	0.	0.0	0.0	0.0
11	15.0	69503.3	0.0	13645.1	0.	0.	0.0	0.0	0.0
12	15.0	76794.1	0.0	13412.9	0.	0.	0.0	0.0	0.0
13	14.9	81718.0	0.0	12152.5	0.	0.	0.0	0.0	0.0
14	14.7	84200.0	0.0	9870.9	0.	0.	0.0	0.0	0.0
15	14.4	84237.6	0.0	6579.9	0.	0.	0.0	0.0	0.0
16	13.8	80383.3	0.0	2297.9	0.	0.	0.0	0.0	0.0
17	0.3	1525.4	0.0	0.0	0.	0.	0.0	0.0	0.0
18	13.7	77669.9	0.0	0.0	0.	0.	0.0	0.0	0.0
19	13.2	71738.7	0.0	0.0	0.	0.	0.0	0.0	0.0
20	12.7	64131.7	0.0	0.0	0.	0.	0.0	0.0	0.0
21	12.0	55164.8	0.0	0.0	0.	0.	0.0	0.0	0.0
22	11.3	45207.3	0.0	0.0	0.	0.	0.0	0.0	0.0
23	2.0	6998.7	0.0	0.0	0.	0.	0.0	0.0	0.0

24	8.6	26666.0	0.0	0.0	0.	0.	0.0	0.0	0.0
25	9.8	20427.5	0.0	0.0	0.	0.	0.0	0.0	0.0
26	8.9	8114.4	0.0	0.0	0.	0.	0.0	0.0	0.0
27	1.9	279.2	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	87.241	6900.000
2	100.783	6893.548
3	114.759	6888.102
4	129.096	6883.690
5	143.716	6880.337
6	158.542	6878.059
7	173.495	6876.869
8	188.495	6876.774
9	203.461	6877.773
10	218.315	6879.863
11	232.977	6883.030
12	247.368	6887.259
13	261.413	6892.527
14	275.035	6898.806
15	288.163	6906.062
16	300.727	6914.258
17	312.659	6923.348
18	323.896	6933.285
19	334.377	6944.015
20	344.048	6955.481
21	352.553	6967.206

Circle Center At X = 182.299 ; Y = 7082.086 ; and Radius = 205.405

Factor of Safety

*** 1.644 ***

*** **GSTABL7** ***

** GSTABL7 by Garry H. Gregory, P.E. **
** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **

****

SLOPE STABILITY ANALYSIS SYSTEM
Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.

****

Analysis Run Date: 12/13/2008
Time of Run: 09:42PM
Run By: Alan Taylor
Input Data Filename: C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engineering\alton coal stock pile ch-5-98 seismic revised a1.in
Output Filename: C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engineering\alton coal stock pile ch-5-98 seismic revised a1.OUT
Unit System: English
Plotted Output Filename: C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engineering\alton coal stock pile ch-5-98 seismic revised a1.PLT
PROBLEM DESCRIPTION: Alton Coal Pile Line A1-A1 - Seismic

BOUNDARY COORDINATES
6 Top Boundaries
6 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	6900.00	107.00	6900.00	1
2	107.00	6900.00	130.00	6905.00	1
3	130.00	6905.00	169.00	6915.00	1
4	169.00	6915.00	323.00	6965.00	1
5	323.00	6965.00	390.00	6970.00	1
6	390.00	6970.00	500.00	6975.00	1

User Specified Y-Origin = 6750.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)

ISOTROPIC SOIL PARAMETERS
4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	107.0	114.1	240.0	19.0	0.00	0.0	1
2	105.0	110.0	90.0	29.0	0.00	0.0	1
3	100.0	120.0	2000.0	0.0	0.00	0.0	1
4	100.0	115.0	300.0	21.0	0.00	0.0	0

1 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water = 62.40 (pcf)
Piezometric Surface No. 1 Specified by 5 Coordinate Points
Pore Pressure Inclination Factor = 0.50

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	6890.00
2	280.00	6890.00
3	330.00	6895.00
4	400.00	6895.00
5	500.00	6895.00

Specified Peak Ground Acceleration Coefficient (A) = 0.291(g)
Specified Horizontal Earthquake Coefficient (kh) = 0.145(g)
Specified Vertical Earthquake Coefficient (kv) = 0.000(g)
Specified Seismic Pore-Pressure Factor = 0.000
A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
900 Trial Surfaces Have Been Generated.
30 Surface(s) Initiate(s) From Each Of 30 Points Equally Spaced
Along The Ground Surface Between X = 50.00(ft)
and X = 140.00(ft)
Each Surface Terminates Between X = 280.00(ft)
and X = 400.00(ft)

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 6700.00(ft)
15.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Evaluated. They Are
Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 900
Number of Trial Surfaces With Valid FS = 900
Statistical Data On All Valid FS Values:
FS Max = 2.177 FS Min = 1.047 FS Ave = 1.171
Standard Deviation = 0.100 Coefficient of Variation = 8.54 %
Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	56.207	6900.000
2	69.107	6892.346
3	82.468	6885.527
4	96.235	6879.571
5	110.352	6874.501
6	124.763	6870.338
7	139.409	6867.099
8	154.231	6864.797
9	169.170	6863.441
10	184.164	6863.037
11	199.154	6863.585
12	214.079	6865.085
13	228.878	6867.530
14	243.492	6870.911
15	257.862	6875.212
16	271.930	6880.418
17	285.639	6886.507
18	298.933	6893.454
19	311.759	6901.232
20	324.065	6909.809
21	335.801	6919.150
22	346.921	6929.218
23	357.378	6939.972
24	367.131	6951.368
25	376.141	6963.361
26	380.008	6969.254

Circle Center At X = 182.986 ; Y = 7098.840 ; and Radius = 235.818
Factor of Safety
*** 1.047 ***
Individual data on the 32 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	12.9	5282.8	0.0	0.0	0.	0.	766.0	0.0	0.0
2	4.6	4341.7	0.0	0.0	0.	0.	629.5	0.0	0.0
3	8.8	11613.1	0.0	1373.0	0.	0.	1683.9	0.0	0.0
4	13.8	26434.5	0.0	6974.3	0.	0.	3833.0	0.0	0.0
5	10.8	26704.0	0.0	8823.8	0.	0.	3872.1	0.0	0.0
6	3.4	9414.4	0.0	3310.6	0.	0.	1365.1	0.0	0.0
7	14.4	47864.6	0.0	16454.9	0.	0.	6940.4	0.0	0.0
8	5.2	20182.4	0.0	6774.8	0.	0.	2926.5	0.0	0.0
9	9.4	39783.2	0.0	13144.5	0.	0.	5768.6	0.0	0.0
10	14.8	71307.0	0.0	22512.5	0.	0.	10339.5	0.0	0.0
11	14.8	80115.1	0.0	23942.7	0.	0.	11616.7	0.0	0.0
12	0.2	968.1	0.0	282.2	0.	0.	140.4	0.0	0.0
13	15.0	89889.4	0.0	25048.5	0.	0.	13034.0	0.0	0.0
14	15.0	97545.6	0.0	24980.9	0.	0.	14144.1	0.0	0.0
15	14.9	103132.7	0.0	24022.0	0.	0.	14954.2	0.0	0.0
16	14.8	106576.8	0.0	22176.0	0.	0.	15453.6	0.0	0.0
17	14.6	107852.9	0.0	19449.9	0.	0.	15638.7	0.0	0.0
18	14.4	106986.8	0.0	15854.4	0.	0.	15513.1	0.0	0.0
19	14.1	104054.9	0.0	11404.7	0.	0.	15088.0	0.0	0.0
20	8.1	58747.3	0.0	4292.3	0.	0.	8518.4	0.0	0.0
21	5.6	40443.7	0.0	1926.0	0.	0.	5864.3	0.0	0.0

22	9.6	67333.9	0.0	1364.1	0.	0.	9763.4	0.0	0.0
23	3.7	25331.6	0.0	0.0	0.	0.	3673.1	0.0	0.0
24	12.8	84984.6	0.0	0.0	0.	0.	12322.8	0.0	0.0
25	11.2	69793.7	0.0	0.0	0.	0.	10120.1	0.0	0.0
26	1.1	6336.1	0.0	0.0	0.	0.	918.7	0.0	0.0
27	11.7	64093.3	0.0	0.0	0.	0.	9293.5	0.0	0.0
28	11.1	50192.2	0.0	0.0	0.	0.	7277.9	0.0	0.0
29	10.5	36455.6	0.0	0.0	0.	0.	5286.1	0.0	0.0
30	9.8	23230.0	0.0	0.0	0.	0.	3368.3	0.0	0.0
31	9.0	10859.8	0.0	0.0	0.	0.	1574.7	0.0	0.0
32	3.9	1159.6	0.0	0.0	0.	0.	168.1	0.0	0.0

Failure Surface Specified By 27 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	53.103	6900.000
2	66.211	6892.706
3	79.712	6886.171
4	93.564	6880.416
5	107.721	6875.459
6	122.138	6871.317
7	136.768	6868.004
8	151.562	6865.530
9	166.474	6863.902
10	181.454	6863.127
11	196.453	6863.208
12	211.424	6864.142
13	226.318	6865.929
14	241.085	6868.561
15	255.678	6872.031
16	270.050	6876.326
17	284.153	6881.434
18	297.943	6887.336
19	311.374	6894.016
20	324.402	6901.449
21	336.986	6909.613
22	349.084	6918.481
23	360.657	6928.024
24	371.667	6938.211
25	382.079	6949.009
26	391.858	6960.383
27	399.550	6970.434

Circle Center At X = 187.549 ; Y = 7126.167 ; and Radius = 263.110

Factor of Safety

*** 1.048 ***

APPENDIX E-2

OUPTUT FILES OF STATIC AND PSEUDO-STATIC SLOPE STABILITY ANALYSES

LINE A2-A2

***** GSTABL7 *****

** GSTABL7 by Garry H. Gregory, P.E. **
** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **

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SLOPE STABILITY ANALYSIS SYSTEM
Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.

****

Analysis Run Date: 12/13/2008
Time of Run: 09:37PM
Run By: Alan Taylor
Input Data Filename: C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engineering\alton coal stock pile ch-5-98 seismic revised a2.in
Output Filename: C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engineering\alton coal stock pile ch-5-98 seismic revised a2.OUT
Unit System: English
Plotted Output Filename: C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engineering\alton coal stock pile ch-5-98 seismic revised a2.PLT
PROBLEM DESCRIPTION: Alton Coal Pile Line A2-A2 - Static
BOUNDARY COORDINATES
6 Top Boundaries
6 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	6880.00	145.00	6885.00	2
2	145.00	6885.00	245.00	6910.00	1
3	245.00	6910.00	308.00	6930.00	1
4	308.00	6930.00	398.00	6960.00	1
5	398.00	6960.00	513.00	6965.00	1
6	513.00	6965.00	600.00	6966.00	1

User Specified Y-Origin = 6750.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	107.0	114.1	240.0	19.0	0.00	0.0	1
2	105.0	110.0	90.0	29.0	0.00	0.0	1
3	100.0	120.0	2000.0	0.0	0.00	0.0	1
4	100.0	115.0	300.0	21.0	0.00	0.0	0

1 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water = 62.40 (pcf)
Piezometric Surface No. 1 Specified by 5 Coordinate Points
Pore Pressure Inclination Factor = 0.50

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	6870.00
2	280.00	6870.00
3	330.00	6870.00
4	400.00	6870.00
5	500.00	6870.00

Specified Peak Ground Acceleration Coefficient (A) = 0.291(g)
Specified Horizontal Earthquake Coefficient (kh) = 0.145(g)
Specified Vertical Earthquake Coefficient (kv) = 0.000(g)
Specified Seismic Pore-Pressure Factor = 0.000
EARTHQUAKE DATA HAS BEEN SUPPRESSED
A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
900 Trial Surfaces Have Been Generated.
30 Surface(s) Initiate(s) From Each Of 30 Points Equally Spaced
Along The Ground Surface Between X = 50.00(ft)
and X = 200.00(ft)
Each Surface Terminates Between X = 380.00(ft)

and X = 500.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 6700.00(ft)
15.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Evaluated. They Are
Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 900
Number of Trial Surfaces With Valid FS = 900
Statistical Data On All Valid FS Values:
FS Max = 2.380 FS Min = 1.654 FS Ave = 1.857
Standard Deviation = 0.126 Coefficient of Variation = 6.77 %
Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	137.931	6884.756
2	152.420	6880.874
3	167.091	6877.749
4	181.904	6875.388
5	196.819	6873.799
6	211.797	6872.986
7	226.797	6872.951
8	241.779	6873.694
9	256.702	6875.213
10	271.526	6877.504
11	286.211	6880.561
12	300.718	6884.375
13	315.007	6888.937
14	329.041	6894.233
15	342.781	6900.251
16	356.191	6906.973
17	369.233	6914.382
18	381.874	6922.457
19	394.079	6931.177
20	405.815	6940.518
21	417.051	6950.456
22	427.757	6960.962
23	428.074	6961.308

Circle Center At X = 219.974 ; Y = 7161.964 ; and Radius = 289.094
Factor of Safety
*** 1.654 ***
Individual data on the 26 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	7.1	793.3	0.0	0.0	0.	0.	0.0	0.0	0.0
2	7.4	3223.0	0.0	0.0	0.	0.	0.0	0.0	0.0
3	14.7	14720.4	0.0	0.0	0.	0.	0.0	0.0	0.0
4	14.8	25052.8	0.0	0.0	0.	0.	0.0	0.0	0.0
5	14.9	34307.9	0.0	0.0	0.	0.	0.0	0.0	0.0
6	15.0	42365.1	0.0	0.0	0.	0.	0.0	0.0	0.0
7	15.0	49121.6	0.0	0.0	0.	0.	0.0	0.0	0.0
8	15.0	54502.3	0.0	0.0	0.	0.	0.0	0.0	0.0
9	3.2	12318.2	0.0	0.0	0.	0.	0.0	0.0	0.0
10	11.7	46627.8	0.0	0.0	0.	0.	0.0	0.0	0.0
11	14.8	62985.9	0.0	0.0	0.	0.	0.0	0.0	0.0
12	14.7	65555.1	0.0	0.0	0.	0.	0.0	0.0	0.0
13	14.5	66618.9	0.0	0.0	0.	0.	0.0	0.0	0.0
14	7.3	33744.6	0.0	0.0	0.	0.	0.0	0.0	0.0
15	7.0	32503.3	0.0	0.0	0.	0.	0.0	0.0	0.0
16	14.0	64703.9	0.0	0.0	0.	0.	0.0	0.0	0.0
17	13.7	61838.2	0.0	0.0	0.	0.	0.0	0.0	0.0
18	13.4	57702.7	0.0	0.0	0.	0.	0.0	0.0	0.0
19	13.0	52417.1	0.0	0.0	0.	0.	0.0	0.0	0.0
20	12.6	46120.9	0.0	0.0	0.	0.	0.0	0.0	0.0
21	12.2	38971.5	0.0	0.0	0.	0.	0.0	0.0	0.0
22	3.9	11163.5	0.0	0.0	0.	0.	0.0	0.0	0.0
23	7.8	19034.8	0.0	0.0	0.	0.	0.0	0.0	0.0

24	11.2	18150.5	0.0	0.0	0.	0.	0.0	0.0	0.0
25	10.7	6130.6	0.0	0.0	0.	0.	0.0	0.0	0.0
26	0.3	5.6	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	127.586	6884.399
2	142.305	6881.510
3	157.137	6879.271
4	172.053	6877.685
5	187.024	6876.755
6	202.022	6876.484
7	217.017	6876.873
8	231.980	6877.919
9	246.883	6879.622
10	261.697	6881.977
11	276.393	6884.981
12	290.943	6888.627
13	305.319	6892.910
14	319.493	6897.819
15	333.438	6903.346
16	347.126	6909.480
17	360.532	6916.210
18	373.629	6923.522
19	386.392	6931.402
20	398.797	6939.835
21	410.820	6948.805
22	422.436	6958.294
23	425.695	6961.204

Circle Center At X = 200.688 ; Y = 7217.908 ; and Radius = 341.426

Factor of Safety

*** 1.658 ***

***** GSTABL7 *****

** GSTABL7 by Garry H. Gregory, P.E. **
** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **

****

SLOPE STABILITY ANALYSIS SYSTEM
Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.

****

Analysis Run Date: 12/13/2008
Time of Run: 09:38PM
Run By: Alan Taylor
Input Data Filename: C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engineering\alton coal stock pile ch-5-98 seismic revised a2.in
Output Filename: C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engineering\alton coal stock pile ch-5-98 seismic revised a2.OUT
Unit System: English
Plotted Output Filename: C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engineering\alton coal stock pile ch-5-98 seismic revised a2.PLT
PROBLEM DESCRIPTION: Alton Coal Pile Line A2-A2 - Seismic

BOUNDARY COORDINATES
6 Top Boundaries
6 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	6880.00	145.00	6885.00	2
2	145.00	6885.00	245.00	6910.00	1
3	245.00	6910.00	308.00	6930.00	1
4	308.00	6930.00	398.00	6960.00	1
5	398.00	6960.00	513.00	6965.00	1
6	513.00	6965.00	600.00	6966.00	1

User Specified Y-Origin = 6750.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)

ISOTROPIC SOIL PARAMETERS
4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	107.0	114.1	240.0	19.0	0.00	0.0	1
2	105.0	110.0	90.0	29.0	0.00	0.0	1
3	100.0	120.0	2000.0	0.0	0.00	0.0	1
4	100.0	115.0	300.0	21.0	0.00	0.0	0

1 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water = 62.40 (pcf)
Piezometric Surface No. 1 Specified by 5 Coordinate Points
Pore Pressure Inclination Factor = 0.50

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	6870.00
2	280.00	6870.00
3	330.00	6870.00
4	400.00	6870.00
5	500.00	6870.00

Specified Peak Ground Acceleration Coefficient (A) = 0.291(g)
Specified Horizontal Earthquake Coefficient (kh) = 0.145(g)
Specified Vertical Earthquake Coefficient (kv) = 0.000(g)
Specified Seismic Pore-Pressure Factor = 0.000
A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
900 Trial Surfaces Have Been Generated.
30 Surface(s) Initiate(s) From Each Of 30 Points Equally Spaced
Along The Ground Surface Between X = 50.00(ft)
and X = 200.00(ft)
Each Surface Terminates Between X = 380.00(ft)
and X = 500.00(ft)

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 6700.00(ft)
15.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Evaluated. They Are
Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 900
Number of Trial Surfaces With Valid FS = 900
Statistical Data On All Valid FS Values:
FS Max = 1.592 FS Min = 1.073 FS Ave = 1.177
Standard Deviation = 0.084 Coefficient of Variation = 7.10 %
Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	143.103	6884.935
2	157.834	6882.103
3	172.673	6879.911
4	187.593	6878.363
5	202.566	6877.463
6	217.564	6877.212
7	232.558	6877.611
8	247.522	6878.658
9	262.426	6880.352
10	277.242	6882.689
11	291.944	6885.666
12	306.503	6889.276
13	320.892	6893.514
14	335.084	6898.370
15	349.053	6903.835
16	362.772	6909.901
17	376.216	6916.555
18	389.359	6923.784
19	402.176	6931.576
20	414.645	6939.915
21	426.740	6948.786
22	438.441	6958.172
23	442.749	6961.946

Circle Center At X = 215.861 ; Y = 7223.639 ; and Radius = 346.431
Factor of Safety
*** 1.073 ***
Individual data on the 26 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	1.9	42.8	0.0	0.0	0.	0.	6.2	0.0	0.0
2	12.8	4487.1	0.0	0.0	0.	0.	650.6	0.0	0.0
3	14.8	14380.7	0.0	0.0	0.	0.	2085.2	0.0	0.0
4	14.9	23382.2	0.0	0.0	0.	0.	3390.4	0.0	0.0
5	15.0	31411.7	0.0	0.0	0.	0.	4554.7	0.0	0.0
6	15.0	38399.4	0.0	0.0	0.	0.	5567.9	0.0	0.0
7	15.0	44288.0	0.0	0.0	0.	0.	6421.8	0.0	0.0
8	12.4	40468.4	0.0	0.0	0.	0.	5867.9	0.0	0.0
9	2.5	8588.5	0.0	0.0	0.	0.	1245.3	0.0	0.0
10	14.9	53680.5	0.0	0.0	0.	0.	7783.7	0.0	0.0
11	14.8	57649.3	0.0	0.0	0.	0.	8359.1	0.0	0.0
12	14.7	60393.0	0.0	0.0	0.	0.	8757.0	0.0	0.0
13	14.6	61911.7	0.0	0.0	0.	0.	8977.2	0.0	0.0
14	1.5	6449.1	0.0	0.0	0.	0.	935.1	0.0	0.0
15	12.9	55915.0	0.0	0.0	0.	0.	8107.7	0.0	0.0
16	14.2	61837.8	0.0	0.0	0.	0.	8966.5	0.0	0.0
17	14.0	60165.5	0.0	0.0	0.	0.	8724.0	0.0	0.0
18	13.7	57399.8	0.0	0.0	0.	0.	8323.0	0.0	0.0
19	13.4	53612.1	0.0	0.0	0.	0.	7773.8	0.0	0.0
20	13.1	48882.4	0.0	0.0	0.	0.	7087.9	0.0	0.0
21	8.6	29726.0	0.0	0.0	0.	0.	4310.3	0.0	0.0
22	4.2	13309.4	0.0	0.0	0.	0.	1929.9	0.0	0.0
23	12.5	32962.6	0.0	0.0	0.	0.	4779.6	0.0	0.0
24	12.1	21531.9	0.0	0.0	0.	0.	3122.1	0.0	0.0

25	11.7	10047.3	0.0	0.0	0.	0.	1456.9	0.0	0.0
26	4.3	826.5	0.0	0.0	0.	0.	119.8	0.0	0.0

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	127.586	6884.399
2	142.251	6881.248
3	157.036	6878.717
4	171.915	6876.810
5	186.860	6875.530
6	201.846	6874.881
7	216.846	6874.864
8	231.833	6875.477
9	246.782	6876.721
10	261.664	6878.592
11	276.455	6881.088
12	291.128	6884.205
13	305.656	6887.937
14	320.015	6892.276
15	334.178	6897.216
16	348.121	6902.748
17	361.819	6908.861
18	375.247	6915.545
19	388.382	6922.789
20	401.201	6930.579
21	413.680	6938.902
22	425.798	6947.742
23	437.533	6957.085
24	443.158	6961.963

Circle Center At X = 209.769 ; Y = 7230.776 ; and Radius = 355.992

Factor of Safety

*** 1.074 ***

APPENDIX E-3

OUPTUT FILES OF STATIC AND PSEUDO-STATIC SLOPE STABILITY ANALYSES

LINE B1-B1

***** GSTABL7 *****

** GSTABL7 by Garry H. Gregory, P.E. **
** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **

****

SLOPE STABILITY ANALYSIS SYSTEM
Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.

****

Analysis Run Date: 12/13/2008
Time of Run: 09:34PM
Run By: Alan Taylor
Input Data Filename: C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engineering\Alton Revised\alton coal stock pile ch-5-98 seismic revised b1.in
Output Filename: C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engineering\Alton Revised\alton coal stock pile ch-5-98 seismic revised b1.OUT
Unit System: English
Plotted Output Filename: C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engineering\Alton Revised\alton coal stock pile ch-5-98 seismic revised b1.PLT
PROBLEM DESCRIPTION: Alton Coal Pile Line B1-B1 - Static
BOUNDARY COORDINATES
11 Top Boundaries
14 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	6825.00	122.00	6835.00	2
2	122.00	6835.00	190.00	6850.00	1
3	190.00	6850.00	296.00	6875.00	1
4	296.00	6875.00	367.00	6895.00	1
5	367.00	6895.00	470.00	6930.00	1
6	470.00	6930.00	505.00	6935.00	1
7	505.00	6935.00	555.00	6940.00	1
8	555.00	6940.00	591.00	6945.00	1
9	591.00	6945.00	660.00	6950.00	1
10	660.00	6950.00	726.00	6950.00	1
11	726.00	6950.00	770.00	6945.00	1
12	122.00	6835.00	770.00	6835.00	2
13	0.00	6817.00	770.00	6817.00	3
14	0.00	6800.00	770.00	6800.00	4

User Specified Y-Origin = 6750.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	107.0	114.1	240.0	19.0	0.00	0.0	1
2	105.0	110.0	90.0	29.0	0.00	0.0	1
3	100.0	120.0	2000.0	0.0	0.00	0.0	1
4	100.0	115.0	300.0	21.0	0.00	0.0	0

1 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water = 62.40 (pcf)
Piezometric Surface No. 1 Specified by 3 Coordinate Points
Pore Pressure Inclination Factor = 0.50

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	6815.00
2	280.00	6816.00
3	770.00	6816.00

Specified Peak Ground Acceleration Coefficient (A) = 0.291(g)
Specified Horizontal Earthquake Coefficient (kh) = 0.145(g)
Specified Vertical Earthquake Coefficient (kv) = 0.000(g)
Specified Seismic Pore-Pressure Factor = 0.000
EARTHQUAKE DATA HAS BEEN SUPPRESSED

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
900 Trial Surfaces Have Been Generated.
30 Surface(s) Initiate(s) From Each Of 30 Points Equally Spaced
Along The Ground Surface Between X = 50.00(ft)
and X = 140.00(ft)
Each Surface Terminates Between X = 400.00(ft)
and X = 700.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 6750.00(ft)
15.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Evaluated. They Are
Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 900
Number of Trial Surfaces With Valid FS = 900
Statistical Data On All Valid FS Values:
FS Max = 2.875 FS Min = 1.708 FS Ave = 2.249
Standard Deviation = 0.255 Coefficient of Variation = 11.32 %
Failure Surface Specified By 37 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	102.759	6833.423
2	116.714	6827.923
3	130.851	6822.909
4	145.154	6818.388
5	159.604	6814.364
6	174.185	6810.843
7	188.879	6807.829
8	203.668	6805.325
9	218.536	6803.334
10	233.463	6801.859
11	248.432	6800.902
12	263.426	6800.463
13	278.426	6800.543
14	293.414	6801.143
15	308.372	6802.261
16	323.283	6803.896
17	338.128	6806.045
18	352.890	6808.708
19	367.550	6811.879
20	382.093	6815.557
21	396.499	6819.735
22	410.752	6824.409
23	424.835	6829.574
24	438.731	6835.223
25	452.422	6841.349
26	465.894	6847.946
27	479.129	6855.005
28	492.112	6862.518
29	504.827	6870.475
30	517.259	6878.868
31	529.394	6887.687
32	541.215	6896.919
33	552.710	6906.556
34	563.865	6916.584
35	574.666	6926.993
36	585.100	6937.770
37	591.676	6945.049

Circle Center At X = 268.605 ; Y = 7233.784 ; and Radius = 433.352
Factor of Safety
*** 1.708 ***
Individual data on the 50 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	14.0	4867.4	0.0	0.0	0.	0.	0.0	0.0	0.0
2	5.3	4328.1	0.0	0.0	0.	0.	0.0	0.0	0.0

3	8.9	10702.9	0.0	0.0	0.	0.	0.0	0.0	0.0
4	14.3	26954.3	0.0	0.0	0.	0.	0.0	0.0	0.0
5	5.0	12073.5	0.0	0.0	0.	0.	0.0	0.0	0.0
6	5.2	13950.7	0.0	0.0	0.	0.	0.0	0.0	0.0
7	4.3	12584.1	0.0	167.0	0.	0.	0.0	0.0	0.0
8	14.6	50291.7	0.0	2801.1	0.	0.	0.0	0.0	0.0
9	14.7	61535.0	0.0	5908.5	0.	0.	0.0	0.0	0.0
10	1.1	5120.8	0.0	563.6	0.	0.	0.0	0.0	0.0
11	13.7	67024.4	0.0	7976.3	0.	0.	0.0	0.0	0.0
12	14.9	82112.4	0.0	10692.7	0.	0.	0.0	0.0	0.0
13	14.9	91175.9	0.0	12365.0	0.	0.	0.0	0.0	0.0
14	15.0	99280.5	0.0	13552.8	0.	0.	0.0	0.0	0.0
15	15.0	106381.7	0.0	14256.6	0.	0.	0.0	0.0	0.0
16	15.0	112441.3	0.0	14474.6	0.	0.	0.0	0.0	0.0
17	1.6	12117.7	0.0	1516.2	0.	0.	0.0	0.0	0.0
18	13.4	105304.8	0.0	12670.4	0.	0.	0.0	0.0	0.0
19	2.6	20712.4	0.0	2388.7	0.	0.	0.0	0.0	0.0
20	12.4	100963.8	0.0	10994.4	0.	0.	0.0	0.0	0.0
21	14.9	125521.0	0.0	12094.9	0.	0.	0.0	0.0	0.0
22	14.8	128255.8	0.0	10323.9	0.	0.	0.0	0.0	0.0
23	14.8	129861.0	0.0	8071.6	0.	0.	0.0	0.0	0.0
24	14.1	125431.3	0.0	5194.5	0.	0.	0.0	0.0	0.0
25	0.6	4911.2	0.0	146.9	0.	0.	0.0	0.0	0.0
26	14.5	130418.9	0.0	2136.2	0.	0.	0.0	0.0	0.0
27	1.5	13778.3	0.0	22.0	0.	0.	0.0	0.0	0.0
28	3.4	31124.9	0.0	0.0	0.	0.	0.0	0.0	0.0
29	9.4	85504.0	0.0	0.0	0.	0.	0.0	0.0	0.0
30	14.3	129833.2	0.0	0.0	0.	0.	0.0	0.0	0.0
31	14.1	128261.4	0.0	0.0	0.	0.	0.0	0.0	0.0
32	13.3	120803.0	0.0	0.0	0.	0.	0.0	0.0	0.0
33	0.5	4932.7	0.0	0.0	0.	0.	0.0	0.0	0.0
34	13.7	122204.0	0.0	0.0	0.	0.	0.0	0.0	0.0
35	13.5	117721.5	0.0	0.0	0.	0.	0.0	0.0	0.0
36	4.1	35262.5	0.0	0.0	0.	0.	0.0	0.0	0.0
37	9.1	76271.3	0.0	0.0	0.	0.	0.0	0.0	0.0
38	13.0	102063.0	0.0	0.0	0.	0.	0.0	0.0	0.0
39	12.7	91931.5	0.0	0.0	0.	0.	0.0	0.0	0.0
40	0.2	1191.7	0.0	0.0	0.	0.	0.0	0.0	0.0
41	12.3	79863.0	0.0	0.0	0.	0.	0.0	0.0	0.0
42	12.1	69534.0	0.0	0.0	0.	0.	0.0	0.0	0.0
43	11.8	57842.1	0.0	0.0	0.	0.	0.0	0.0	0.0
44	11.5	46073.1	0.0	0.0	0.	0.	0.0	0.0	0.0
45	2.3	7913.0	0.0	0.0	0.	0.	0.0	0.0	0.0
46	8.9	26575.3	0.0	0.0	0.	0.	0.0	0.0	0.0
47	10.8	23337.0	0.0	0.0	0.	0.	0.0	0.0	0.0
48	10.4	12364.5	0.0	0.0	0.	0.	0.0	0.0	0.0
49	5.9	2244.5	0.0	0.0	0.	0.	0.0	0.0	0.0
50	0.7	25.3	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 36 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	102.759	6833.423
2	116.653	6827.770
3	130.748	6822.638
4	145.023	6818.034
5	159.461	6813.963
6	174.039	6810.433
7	188.739	6807.447
8	203.540	6805.009
9	218.421	6803.124
10	233.362	6801.793
11	248.342	6801.020
12	263.340	6800.803
13	278.336	6801.145
14	293.309	6802.043
15	308.238	6803.499
16	323.103	6805.508
17	337.883	6808.068
18	352.557	6811.177
19	367.106	6814.829

20	381.509	6819.020
21	395.746	6823.743
22	409.797	6828.992
23	423.644	6834.761
24	437.266	6841.040
25	450.646	6847.822
26	463.764	6855.096
27	476.602	6862.854
28	489.143	6871.083
29	501.370	6879.772
30	513.264	6888.911
31	524.811	6898.486
32	535.994	6908.483
33	546.797	6918.890
34	557.206	6929.690
35	567.206	6940.871
36	567.979	6941.803

Circle Center At X = 261.654 ; Y = 7204.033 ; and Radius = 403.237

Factor of Safety

*** 1.716 ***

Failure Surface Specified By 32 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	112.069	6834.186
2	125.621	6827.755
3	139.459	6821.967
4	153.554	6816.834
5	167.873	6812.368
6	182.387	6808.579
7	197.062	6805.474
8	211.866	6803.060
9	226.768	6801.343
10	241.733	6800.327
11	256.730	6800.014
12	271.725	6800.405
13	286.685	6801.498
14	301.577	6803.292
15	316.369	6805.781
16	331.028	6808.962
17	345.522	6812.826
18	359.818	6817.366
19	373.886	6822.571
20	387.695	6828.431
21	401.213	6834.931
22	414.412	6842.058
23	427.262	6849.795
24	439.735	6858.127
25	451.804	6867.035
26	463.441	6876.499
27	474.622	6886.498
28	485.322	6897.010
29	495.518	6908.013
30	505.186	6919.481
31	514.305	6931.391
32	517.691	6936.269

Circle Center At X = 255.886 ; Y = 7119.638 ; and Radius = 319.634

Factor of Safety

*** 1.727 ***

***** GSTABL7 *****

** GSTABL7 by Garry H. Gregory, P.E. **
** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **

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SLOPE STABILITY ANALYSIS SYSTEM
Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.

****

Analysis Run Date: 12/13/2008
Time of Run: 09:32PM
Run By: Alan Taylor
Input Data Filename: C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engineering\Alton Revised\alton coal stock pile ch-5-98 seismic revised b1.in
Output Filename: C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engineering\Alton Revised\alton coal stock pile ch-5-98 seismic revised b1.OUT
Unit System: English
Plotted Output Filename: C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engineering\Alton Revised\alton coal stock pile ch-5-98 seismic revised b1.PLT
PROBLEM DESCRIPTION: Alton Coal Pile Line B1-B1 - Seismic
BOUNDARY COORDINATES
11 Top Boundaries
14 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	6825.00	122.00	6835.00	2
2	122.00	6835.00	190.00	6850.00	1
3	190.00	6850.00	296.00	6875.00	1
4	296.00	6875.00	367.00	6895.00	1
5	367.00	6895.00	470.00	6930.00	1
6	470.00	6930.00	505.00	6935.00	1
7	505.00	6935.00	555.00	6940.00	1
8	555.00	6940.00	591.00	6945.00	1
9	591.00	6945.00	660.00	6950.00	1
10	660.00	6950.00	726.00	6950.00	1
11	726.00	6950.00	770.00	6945.00	1
12	122.00	6835.00	770.00	6835.00	2
13	0.00	6817.00	770.00	6817.00	3
14	0.00	6800.00	770.00	6800.00	4

User Specified Y-Origin = 6750.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	107.0	114.1	240.0	19.0	0.00	0.0	1
2	105.0	110.0	90.0	29.0	0.00	0.0	1
3	100.0	120.0	2000.0	0.0	0.00	0.0	1
4	100.0	115.0	300.0	21.0	0.00	0.0	0

1 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water = 62.40 (pcf)
Piezometric Surface No. 1 Specified by 3 Coordinate Points
Pore Pressure Inclination Factor = 0.50

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	6815.00
2	280.00	6816.00
3	770.00	6816.00

Specified Peak Ground Acceleration Coefficient (A) = 0.291(g)
Specified Horizontal Earthquake Coefficient (kh) = 0.145(g)
Specified Vertical Earthquake Coefficient (kv) = 0.000(g)
Specified Seismic Pore-Pressure Factor = 0.000
A Critical Failure Surface Searching Method, Using A Random

Technique For Generating Circular Surfaces, Has Been Specified.
900 Trial Surfaces Have Been Generated.
30 Surface(s) Initiate(s) From Each Of 30 Points Equally Spaced
Along The Ground Surface Between X = 50.00(ft)
and X = 140.00(ft)
Each Surface Terminates Between X = 400.00(ft)
and X = 700.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 6750.00(ft)
15.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Evaluated. They Are
Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 900
Number of Trial Surfaces With Valid FS = 900
Statistical Data On All Valid FS Values:
FS Max = 1.741 FS Min = 1.051 FS Ave = 1.397
Standard Deviation = 0.167 Coefficient of Variation = 11.98 %
Failure Surface Specified By 40 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	90.345	6832.405
2	104.479	6827.384
3	118.754	6822.776
4	133.157	6818.585
5	147.675	6814.815
6	162.297	6811.468
7	177.010	6808.547
8	191.801	6806.055
9	206.659	6803.995
10	221.571	6802.367
11	236.523	6801.173
12	251.504	6800.414
13	266.500	6800.091
14	281.500	6800.205
15	296.490	6800.753
16	311.457	6801.738
17	326.390	6803.157
18	341.275	6805.010
19	356.100	6807.294
20	370.853	6810.009
21	385.520	6813.151
22	400.090	6816.718
23	414.549	6820.708
24	428.887	6825.115
25	443.091	6829.938
26	457.148	6835.171
27	471.047	6840.812
28	484.777	6846.853
29	498.325	6853.291
30	511.680	6860.120
31	524.831	6867.334
32	537.767	6874.928
33	550.477	6882.895
34	562.949	6891.228
35	575.174	6899.919
36	587.142	6908.963
37	598.841	6918.350
38	610.263	6928.074
39	621.397	6938.125
40	631.660	6947.946

Circle Center At X = 270.107 ; Y = 7316.028 ; and Radius = 515.951
Factor of Safety
*** 1.051 ***
Individual data on the 53 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)

1	14.1	4585.8	0.0	0.0	0.	0.	664.9	0.0	0.0
2	14.3	13592.8	0.0	0.0	0.	0.	1970.9	0.0	0.0
3	3.2	4281.6	0.0	0.0	0.	0.	620.8	0.0	0.0
4	11.2	18796.5	0.0	0.0	0.	0.	2725.5	0.0	0.0
5	6.1	13077.4	0.0	0.0	0.	0.	1896.2	0.0	0.0
6	5.7	13919.7	0.0	0.0	0.	0.	2018.4	0.0	0.0
7	2.7	7183.6	0.0	62.1	0.	0.	1041.6	0.0	0.0
8	14.6	45366.4	0.0	2257.7	0.	0.	6578.1	0.0	0.0
9	14.7	56291.5	0.0	5240.3	0.	0.	8162.3	0.0	0.0
10	13.0	57942.9	0.0	6742.7	0.	0.	8401.7	0.0	0.0
11	1.8	8622.2	0.0	1080.0	0.	0.	1250.2	0.0	0.0
12	14.9	76356.4	0.0	10002.6	0.	0.	11071.7	0.0	0.0
13	14.9	85549.3	0.0	11778.6	0.	0.	12404.6	0.0	0.0
14	15.0	93966.5	0.0	13149.2	0.	0.	13625.1	0.0	0.0
15	15.0	101573.8	0.0	14113.1	0.	0.	14728.2	0.0	0.0
16	15.0	108341.7	0.0	14668.9	0.	0.	15709.5	0.0	0.0
17	13.5	102575.7	0.0	13338.7	0.	0.	14873.5	0.0	0.0
18	1.5	11670.5	0.0	1478.9	0.	0.	1692.2	0.0	0.0
19	14.5	115285.3	0.0	14060.9	0.	0.	16716.4	0.0	0.0
20	0.5	3971.1	0.0	466.5	0.	0.	575.8	0.0	0.0
21	15.0	123945.0	0.0	13810.1	0.	0.	17972.0	0.0	0.0
22	14.9	128231.4	0.0	12685.4	0.	0.	18593.6	0.0	0.0
23	14.9	131589.3	0.0	11153.8	0.	0.	19080.5	0.0	0.0
24	14.8	134015.0	0.0	9217.4	0.	0.	19432.2	0.0	0.0
25	10.9	99950.7	0.0	5326.8	0.	0.	14492.9	0.0	0.0
26	3.9	35604.5	0.0	1551.2	0.	0.	5162.7	0.0	0.0
27	14.7	137096.2	0.0	4137.0	0.	0.	19879.0	0.0	0.0
28	11.6	110146.8	0.0	1065.1	0.	0.	15971.3	0.0	0.0
29	2.9	27937.9	0.0	0.0	0.	0.	4051.0	0.0	0.0
30	1.0	9748.2	0.0	0.0	0.	0.	1413.5	0.0	0.0
31	13.4	129009.9	0.0	0.0	0.	0.	18706.4	0.0	0.0
32	14.3	138773.0	0.0	0.0	0.	0.	20122.1	0.0	0.0
33	14.2	137960.8	0.0	0.0	0.	0.	20004.3	0.0	0.0
34	13.6	131884.2	0.0	0.0	0.	0.	19123.2	0.0	0.0
35	0.5	4456.3	0.0	0.0	0.	0.	646.2	0.0	0.0
36	12.9	123816.4	0.0	0.0	0.	0.	17953.4	0.0	0.0
37	1.0	10026.8	0.0	0.0	0.	0.	1453.9	0.0	0.0
38	13.7	128246.1	0.0	0.0	0.	0.	18595.7	0.0	0.0
39	13.5	120329.6	0.0	0.0	0.	0.	17447.8	0.0	0.0
40	6.7	56800.6	0.0	0.0	0.	0.	8236.1	0.0	0.0
41	6.7	54981.1	0.0	0.0	0.	0.	7972.3	0.0	0.0
42	13.2	102157.5	0.0	0.0	0.	0.	14812.8	0.0	0.0
43	12.9	92042.6	0.0	0.0	0.	0.	13346.2	0.0	0.0
44	12.7	81596.3	0.0	0.0	0.	0.	11831.5	0.0	0.0
45	4.5	26798.8	0.0	0.0	0.	0.	3885.8	0.0	0.0
46	7.9	44212.1	0.0	0.0	0.	0.	6410.8	0.0	0.0
47	12.2	60668.5	0.0	0.0	0.	0.	8796.9	0.0	0.0
48	12.0	50185.5	0.0	0.0	0.	0.	7276.9	0.0	0.0
49	3.9	14127.9	0.0	0.0	0.	0.	2048.6	0.0	0.0
50	7.8	25236.6	0.0	0.0	0.	0.	3659.3	0.0	0.0
51	11.4	27827.4	0.0	0.0	0.	0.	4035.0	0.0	0.0
52	11.1	16321.2	0.0	0.0	0.	0.	2366.6	0.0	0.0
53	10.3	4984.7	0.0	0.0	0.	0.	722.8	0.0	0.0

APPENDIX E-4

OUPTUT FILES OF STATIC AND PSEUDO-STATIC SLOPE STABILITY ANALYSES

LINE B2-B2

*** **GSTABL7** ***

** GSTABL7 by Garry H. Gregory, P.E. **
** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **

****

SLOPE STABILITY ANALYSIS SYSTEM
Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.

****

Analysis Run Date: 12/13/2008
Time of Run: 09:13PM
Run By: Alan Taylor
Input Data Filename: C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engineering\Alton Revised\alton coal stock pile ch-5-98 seismic revised b2.in
Output Filename: C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engineering\Alton Revised\alton coal stock pile ch-5-98 seismic revised b2.OUT
Unit System: English
Plotted Output Filename: C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engineering\Alton Revised\alton coal stock pile ch-5-98 seismic revised b2.PLT
PROBLEM DESCRIPTION: Alton Coal Pile Line B2-B2 - Static
BOUNDARY COORDINATES
7 Top Boundaries
10 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	6810.00	200.00	6815.00	2
2	200.00	6815.00	241.00	6820.00	1
3	241.00	6820.00	308.00	6835.00	1
4	308.00	6835.00	476.00	6875.00	1
5	476.00	6875.00	617.00	6925.00	1
6	617.00	6925.00	686.00	6925.00	1
7	686.00	6925.00	730.00	6910.00	1
8	241.00	6820.00	730.00	6820.00	2
9	0.00	6806.00	730.00	6812.00	3
10	0.00	6800.00	730.00	6800.00	4

User Specified Y-Origin = 6750.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	107.0	114.1	240.0	19.0	0.00	0.0	1
2	105.0	110.0	90.0	29.0	0.00	0.0	1
3	100.0	120.0	2000.0	0.0	0.00	0.0	1
4	100.0	115.0	300.0	21.0	0.00	0.0	0

1 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water = 62.40 (pcf)
Piezometric Surface No. 1 Specified by 3 Coordinate Points
Pore Pressure Inclination Factor = 0.50

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	6801.00
2	280.00	6801.00
3	730.00	6801.00

Specified Peak Ground Acceleration Coefficient (A) = 0.291(g)
Specified Horizontal Earthquake Coefficient (kh) = 0.145(g)
Specified Vertical Earthquake Coefficient (kv) = 0.000(g)
Specified Seismic Pore-Pressure Factor = 0.000
EARTHQUAKE DATA HAS BEEN SUPPRESSED
A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.
900 Trial Surfaces Have Been Generated.
30 Surface(s) Initiate(s) From Each Of 30 Points Equally Spaced

```
Along The Ground Surface Between  X = 100.00(ft)
                            and   X = 400.00(ft)
Each Surface Terminates Between   X = 400.00(ft)
                            and   X = 650.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is  Y =   6750.00(ft)
15.00(ft) Line Segments Define Each Trial Failure Surface.
****  ERROR - RC11  ****
```

>>200 attempts to generate failure surface have failed. Revise limitations

```
The Factor Of Safety For The Trial Failure Surface Defined
By The Coordinates Listed Below Is Misleading.
Failure Surface Defined By  3 Coordinate Points
```

Point No.	X-Surf (ft)	Y-Surf (ft)
1	389.66	6854.44
2	400.39	6843.97
3	406.74	6858.51

```
Factor Of Safety For The Preceding Specified Surface =-12.950
Following Are Displayed The Ten Most Critical Of The Trial
     Failure Surfaces Evaluated. They Are
     Ordered - Most Critical First.
     * * Safety Factors Are Calculated By The Modified Bishop Method * *
     Total Number of Trial Surfaces Attempted =   900
     Number of Trial Surfaces with Misleading FS =    1
     Number of Failed Attempts to Generate Trial Surface  =   59
     Number of Trial Surfaces With Valid FS =  840
     Percentage of Trial Surfaces With Non-Valid FS Solutions
     of the Total Attempted =   6.7 %
     Statistical Data On All Valid FS Values:
        FS Max =  10.391   FS Min =   1.611   FS Ave =   2.859
        Standard Deviation =    0.835   Coefficient of Variation =   29.20 %
     Failure Surface Specified By 22 Coordinate Points
```

Point No.	X-Surf (ft)	Y-Surf (ft)
1	358.621	6847.053
2	373.280	6843.875
3	388.076	6841.411
4	402.975	6839.668
5	417.940	6838.650
6	432.937	6838.359
7	447.931	6838.795
8	462.886	6839.959
9	477.767	6841.847
10	492.538	6844.454
11	507.166	6847.774
12	521.616	6851.801
13	535.853	6856.523
14	549.844	6861.931
15	563.557	6868.011
16	576.958	6874.749
17	590.017	6882.128
18	602.703	6890.133
19	614.985	6898.744
20	626.836	6907.940
21	638.226	6917.701
22	645.952	6925.000

```
     Circle Center At X =   431.437 ; Y =   7147.192 ; and Radius =   308.846
             Factor of Safety
            ***   1.611   ***
            Individual data on the    23  slices
```

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	14.7	5230.3	0.0	0.0	0.	0.	0.0	0.0	0.0
2	14.8	15296.3	0.0	0.0	0.	0.	0.0	0.0	0.0
3	14.9	24389.9	0.0	0.0	0.	0.	0.0	0.0	0.0
4	15.0	32402.8	0.0	0.0	0.	0.	0.0	0.0	0.0
5	15.0	39246.1	0.0	0.0	0.	0.	0.0	0.0	0.0
6	15.0	44848.1	0.0	0.0	0.	0.	0.0	0.0	0.0

7	15.0	49156.6	0.0	0.0	0.	0.	0.0	0.0	0.0
8	13.1	45812.3	0.0	0.0	0.	0.	0.0	0.0	0.0
9	1.8	6346.9	0.0	0.0	0.	0.	0.0	0.0	0.0
10	14.8	55470.5	0.0	0.0	0.	0.	0.0	0.0	0.0
11	14.6	58449.6	0.0	0.0	0.	0.	0.0	0.0	0.0
12	14.4	60029.1	0.0	0.0	0.	0.	0.0	0.0	0.0
13	14.2	60231.7	0.0	0.0	0.	0.	0.0	0.0	0.0
14	14.0	59101.7	0.0	0.0	0.	0.	0.0	0.0	0.0
15	13.7	56703.2	0.0	0.0	0.	0.	0.0	0.0	0.0
16	13.4	53121.9	0.0	0.0	0.	0.	0.0	0.0	0.0
17	13.1	48455.5	0.0	0.0	0.	0.	0.0	0.0	0.0
18	12.7	42824.4	0.0	0.0	0.	0.	0.0	0.0	0.0
19	12.3	36363.5	0.0	0.0	0.	0.	0.0	0.0	0.0
20	2.0	5414.5	0.0	0.0	0.	0.	0.0	0.0	0.0
21	9.8	21969.9	0.0	0.0	0.	0.	0.0	0.0	0.0
22	11.4	14843.4	0.0	0.0	0.	0.	0.0	0.0	0.0
23	7.7	3017.3	0.0	0.0	0.	0.	0.0	0.0	0.0

***** GSTABL7 *****

** GSTABL7 by Garry H. Gregory, P.E. **
** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **

****

SLOPE STABILITY ANALYSIS SYSTEM
Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.

****

Analysis Run Date: 12/13/2008
Time of Run: 09:19PM
Run By: Alan Taylor
Input Data Filename: C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engineering\Alton Revised\alton coal stock pile ch-5-98 seismic revised b2.in
Output Filename: C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engineering\Alton Revised\alton coal stock pile ch-5-98 seismic revised b2.OUT
Unit System: English
Plotted Output Filename: C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engineering\Alton Revised\alton coal stock pile ch-5-98 seismic revised b2.PLT
PROBLEM DESCRIPTION: Alton Coal Pile Line B2-B2 - Seismic
BOUNDARY COORDINATES
7 Top Boundaries
10 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	6810.00	200.00	6815.00	2
2	200.00	6815.00	241.00	6820.00	1
3	241.00	6820.00	308.00	6835.00	1
4	308.00	6835.00	476.00	6875.00	1
5	476.00	6875.00	617.00	6925.00	1
6	617.00	6925.00	686.00	6925.00	1
7	686.00	6925.00	730.00	6910.00	1
8	241.00	6820.00	730.00	6820.00	2
9	0.00	6806.00	730.00	6812.00	3
10	0.00	6800.00	730.00	6800.00	4

User Specified Y-Origin = 6750.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	107.0	114.1	240.0	19.0	0.00	0.0	1
2	105.0	110.0	90.0	29.0	0.00	0.0	1
3	100.0	120.0	2000.0	0.0	0.00	0.0	1
4	100.0	115.0	300.0	21.0	0.00	0.0	0

1 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water = 62.40 (pcf)
Piezometric Surface No. 1 Specified by 3 Coordinate Points
Pore Pressure Inclination Factor = 0.50

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	6801.00
2	280.00	6801.00
3	730.00	6801.00

Specified Peak Ground Acceleration Coefficient (A) = 0.291(g)
Specified Horizontal Earthquake Coefficient (kh) = 0.145(g)
Specified Vertical Earthquake Coefficient (kv) = 0.000(g)
Specified Seismic Pore-Pressure Factor = 0.000
A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
900 Trial Surfaces Have Been Generated.
30 Surface(s) Initiate(s) From Each Of 30 Points Equally Spaced
Along The Ground Surface Between X = 100.00(ft)

```
                        and   X = 400.00(ft)
Each Surface Terminates Between   X = 400.00(ft)
                        and   X = 650.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is  Y =   6750.00(ft)
20.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
      Failure Surfaces Evaluated. They Are
      Ordered - Most Critical First.
      * * Safety Factors Are Calculated By The Modified Bishop Method * *
      Total Number of Trial Surfaces Attempted =   900
      Number of Failed Attempts to Generate Trial Surface  =   59
      Number of Trial Surfaces With Valid FS =  841
      Percentage of Trial Surfaces With Non-Valid FS Solutions
      of the Total Attempted =   6.6 %
      Statistical Data On All Valid FS Values:
         FS Max =    6.210   FS Min =    1.059   FS Ave =    1.745
         Standard Deviation =    0.440   Coefficient of Variation =   25.23 %
      Failure Surface Specified By 20 Coordinate Points
```

Point No.	X-Surf (ft)	Y-Surf (ft)
1	296.552	6832.437
2	316.164	6828.517
3	335.954	6825.629
4	355.869	6823.782
5	375.853	6822.981
6	395.851	6823.228
7	415.809	6824.522
8	435.672	6826.860
9	455.385	6830.236
10	474.895	6834.639
11	494.146	6840.059
12	513.088	6846.479
13	531.667	6853.883
14	549.833	6862.250
15	567.535	6871.557
16	584.726	6881.779
17	601.357	6892.887
18	617.384	6904.852
19	632.762	6917.639
20	640.725	6925.000

```
      Circle Center At X =    381.148 ; Y =   7204.030 ; and Radius =   381.101
             Factor of Safety
            ***    1.059   ***
            Individual data on the    22  slices
```

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	11.4	2970.9	0.0	0.0	0.	0.	430.8	0.0	0.0
2	8.2	5799.5	0.0	0.0	0.	0.	840.9	0.0	0.0
3	19.8	25891.8	0.0	0.0	0.	0.	3754.3	0.0	0.0
4	19.9	41169.9	0.0	0.0	0.	0.	5969.6	0.0	0.0
5	20.0	54300.7	0.0	0.0	0.	0.	7873.6	0.0	0.0
6	20.0	65118.7	0.0	0.0	0.	0.	9442.2	0.0	0.0
7	20.0	73500.0	0.0	0.0	0.	0.	10657.5	0.0	0.0
8	19.9	79364.6	0.0	0.0	0.	0.	11507.9	0.0	0.0
9	19.7	82679.0	0.0	0.0	0.	0.	11988.5	0.0	0.0
10	19.5	83450.6	0.0	0.0	0.	0.	12100.3	0.0	0.0
11	1.1	4740.1	0.0	0.0	0.	0.	687.3	0.0	0.0
12	18.1	79050.4	0.0	0.0	0.	0.	11462.3	0.0	0.0
13	18.9	84160.1	0.0	0.0	0.	0.	12203.2	0.0	0.0
14	18.6	82033.6	0.0	0.0	0.	0.	11894.9	0.0	0.0
15	18.2	77544.2	0.0	0.0	0.	0.	11243.9	0.0	0.0
16	17.7	70872.9	0.0	0.0	0.	0.	10276.6	0.0	0.0
17	17.2	62244.0	0.0	0.0	0.	0.	9025.4	0.0	0.0
18	16.6	51911.8	0.0	0.0	0.	0.	7527.2	0.0	0.0
19	15.6	39334.7	0.0	0.0	0.	0.	5703.5	0.0	0.0
20	0.4	833.5	0.0	0.0	0.	0.	120.9	0.0	0.0
21	15.4	22632.9	0.0	0.0	0.	0.	3281.8	0.0	0.0

```
22      8.0    3136.2     0.0      0.0        0.      0.   454.8      0.0       0.0
        Failure Surface Specified By 21 Coordinate Points
          Point       X-Surf       Y-Surf
           No.         (ft)         (ft)
            1        275.862      6827.805
            2        295.582      6824.471
            3        315.436      6822.057
            4        335.381      6820.568
            5        355.373      6820.009
            6        375.369      6820.379
            7        395.327      6821.679
            8        415.203      6823.906
            9        434.953      6827.054
           10        454.536      6831.117
           11        473.909      6836.086
           12        493.030      6841.950
           13        511.858      6848.697
           14        530.351      6856.312
           15        548.471      6864.779
           16        566.177      6874.079
           17        583.432      6884.192
           18        600.197      6895.097
           19        616.438      6906.769
           20        632.119      6919.183
           21        638.802      6925.000
        Circle Center At X =   357.404 ; Y =  7250.058 ; and Radius =   430.054
               Factor of Safety
             ***    1.063    ***
```

APPENDIX E-5

OUPTUT FILES OF STATIC, PSEUDO-STATIC and RAPID DRAWDOWN SLOPE STABILITY ANALYSES

LINE F-F, Sedimentation Ponds #1, #1B, #2 and #4

```
                         *** GSTABL7 ***
              ** GSTABL7 by Garry H. Gregory, P.E. **
    ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
              (All Rights Reserved-Unauthorized Use Prohibited)
*********************************************************************************
                     SLOPE STABILITY ANALYSIS SYSTEM
       Modified Bishop, Simplified Janbu, or GLE Method of Slices.
       (Includes Spencer & Morgenstern-Price Type Analysis)
       Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
       Nonlinear Undrained Shear Strength, Curved Phi Envelope,
       Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
       Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*********************************************************************************
   Analysis Run Date:        12/15/2008
   Time of Run:              01:37PM
   Run By:                   Alan Taylor
   Input Data Filename:      C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engi
neering\Alton Revised\alton line ff sp-16-13 static.in
   Output Filename:          C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engi
neering\Alton Revised\alton line ff sp-16-13 static.OUT
   Unit System:              English
   Plotted Output Filename:  C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engi
neering\Alton Revised\alton line ff sp-16-13 static.PLT
   PROBLEM DESCRIPTION:  Alton Coal Hollow Sedimentation Pond 4:
                         Line FF, Soil SP-16-13 - Static
   BOUNDARY COORDINATES
       4 Top   Boundaries
       4 Total Boundaries
   Boundary     X-Left      Y-Left     X-Right     Y-Right     Soil Type
      No.        (ft)        (ft)        (ft)        (ft)      Below Bnd
       1         0.00      6823.00      20.00      6823.00        1
       2        20.00      6823.00      50.00      6838.00        1
       3        50.00      6838.00      62.00      6838.00        1
       4        62.00      6838.00      82.00      6828.00        1
   User Specified Y-Origin =      6750.00(ft)
   Default X-Plus Value = 0.00(ft)
   Default Y-Plus Value = 0.00(ft)
  ISOTROPIC SOIL PARAMETERS
    2 Type(s) of Soil
   Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
   Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
    No.  (pcf)    (pcf)     (psf)     (deg)   Param.    (psf)     No.
     1    99.4    116.2      94.0      29.6    0.00      0.0       1
     2   105.0    110.0      90.0      29.0    0.00      0.0       1
   1 PIEZOMETRIC SURFACE(S) SPECIFIED
   Unit Weight of Water =  62.40 (pcf)
   Piezometric Surface No.  1 Specified by  6 Coordinate Points
   Pore Pressure Inclination Factor =  0.50
     Point       X-Water      Y-Water
      No.         (ft)          (ft)
       1          0.00       6834.00
       2         20.00       6834.00
       3         42.00       6834.00
       4         50.00       6834.00
       5         58.00       6834.00
       6         82.00       6828.00
   Specified Peak Ground Acceleration Coefficient (A) =   0.291(g)
   Specified Horizontal Earthquake Coefficient (kh) =   0.145(g)
   Specified Vertical Earthquake Coefficient (kv) =   0.000(g)
   Specified Seismic Pore-Pressure Factor =   0.000
   EARTHQUAKE DATA HAS BEEN SUPPRESSED
   A Critical Failure Surface Searching Method, Using A Random
   Technique For Generating Circular Surfaces, Has Been Specified.
    400 Trial Surfaces Have Been Generated.
     20 Surface(s) Initiate(s) From Each Of    20 Points Equally Spaced
   Along The Ground Surface Between  X =  10.00(ft)
                                and  X =  45.00(ft)
   Each Surface Terminates Between   X =  48.00(ft)
                                and  X =  60.00(ft)
   Unless Further Limitations Were Imposed, The Minimum Elevation
```

At Which A Surface Extends Is Y = 6700.00(ft)
1.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Evaluated. They Are
Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 400
Number of Trial Surfaces With Valid FS = 400
Statistical Data On All Valid FS Values:
FS Max = 11.984 FS Min = 2.152 FS Ave = 3.229
Standard Deviation = 1.274 Coefficient of Variation = 39.46 %
Failure Surface Specified By 45 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	19.211	6823.000
2	20.192	6822.808
3	21.178	6822.642
4	22.168	6822.503
5	23.162	6822.391
6	24.158	6822.305
7	25.157	6822.246
8	26.156	6822.213
9	27.156	6822.208
10	28.156	6822.230
11	29.155	6822.279
12	30.152	6822.354
13	31.147	6822.457
14	32.138	6822.585
15	33.126	6822.741
16	34.109	6822.923
17	35.087	6823.132
18	36.059	6823.367
19	37.025	6823.627
20	37.983	6823.914
21	38.933	6824.227
22	39.874	6824.564
23	40.806	6824.927
24	41.728	6825.315
25	42.638	6825.728
26	43.538	6826.165
27	44.425	6826.625
28	45.300	6827.110
29	46.162	6827.618
30	47.009	6828.148
31	47.842	6828.702
32	48.659	6829.278
33	49.461	6829.875
34	50.247	6830.494
35	51.015	6831.134
36	51.766	6831.794
37	52.500	6832.474
38	53.214	6833.174
39	53.909	6833.893
40	54.585	6834.629
41	55.241	6835.384
42	55.876	6836.157
43	56.491	6836.946
44	57.083	6837.751
45	57.257	6838.000

Circle Center At X = 26.846 ; Y = 6859.390 ; and Radius = 37.182
Factor of Safety
*** 2.152 ***
Individual data on the 48 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	0.8	7.1	541.9	556.1	0.	0.	0.0	0.0	0.0
2	0.2	4.9	146.6	136.3	0.	0.	0.0	0.0	0.0
3	1.0	70.7	733.3	703.5	0.	0.	0.0	0.0	0.0

4	1.0	145.4	702.2	713.1	0.	0.	0.0	0.0	0.0
5	1.0	217.7	670.2	720.9	0.	0.	0.0	0.0	0.0
6	1.0	287.4	637.4	727.1	0.	0.	0.0	0.0	0.0
7	1.0	354.2	603.9	731.6	0.	0.	0.0	0.0	0.0
8	1.0	417.9	569.8	734.5	0.	0.	0.0	0.0	0.0
9	1.0	478.4	535.2	735.6	0.	0.	0.0	0.0	0.0
10	1.0	535.5	500.2	735.2	0.	0.	0.0	0.0	0.0
11	1.0	588.8	464.9	732.9	0.	0.	0.0	0.0	0.0
12	1.0	638.5	429.5	729.1	0.	0.	0.0	0.0	0.0
13	1.0	684.2	393.9	723.5	0.	0.	0.0	0.0	0.0
14	1.0	726.0	358.3	716.3	0.	0.	0.0	0.0	0.0
15	1.0	763.6	322.8	707.4	0.	0.	0.0	0.0	0.0
16	1.0	797.1	287.5	696.9	0.	0.	0.0	0.0	0.0
17	1.0	826.4	252.5	684.7	0.	0.	0.0	0.0	0.0
18	1.0	851.4	217.9	670.9	0.	0.	0.0	0.0	0.0
19	1.0	872.1	183.8	655.4	0.	0.	0.0	0.0	0.0
20	1.0	888.5	150.3	638.3	0.	0.	0.0	0.0	0.0
21	0.9	900.6	117.4	619.7	0.	0.	0.0	0.0	0.0
22	0.9	908.5	85.3	599.4	0.	0.	0.0	0.0	0.0
23	0.9	912.1	54.0	577.4	0.	0.	0.0	0.0	0.0
24	0.9	911.7	23.6	554.0	0.	0.	0.0	0.0	0.0
25	0.3	270.9	1.3	161.0	0.	0.	0.0	0.0	0.0
26	0.6	634.6	0.0	368.1	0.	0.	0.0	0.0	0.0
27	0.9	890.5	0.0	502.6	0.	0.	0.0	0.0	0.0
28	0.9	871.6	0.0	474.6	0.	0.	0.0	0.0	0.0
29	0.9	849.4	0.0	445.0	0.	0.	0.0	0.0	0.0
30	0.9	823.9	0.0	414.1	0.	0.	0.0	0.0	0.0
31	0.8	795.5	0.0	381.7	0.	0.	0.0	0.0	0.0
32	0.8	764.1	0.0	347.9	0.	0.	0.0	0.0	0.0
33	0.8	730.0	0.0	312.6	0.	0.	0.0	0.0	0.0
34	0.8	693.5	0.0	276.0	0.	0.	0.0	0.0	0.0
35	0.5	451.9	0.0	167.4	0.	0.	0.0	0.0	0.0
36	0.2	201.5	0.0	70.6	0.	0.	0.0	0.0	0.0
37	0.8	590.1	0.0	198.8	0.	0.	0.0	0.0	0.0
38	0.8	520.0	0.0	158.3	0.	0.	0.0	0.0	0.0
39	0.7	450.4	0.0	116.5	0.	0.	0.0	0.0	0.0
40	0.7	381.7	0.0	73.4	0.	0.	0.0	0.0	0.0
41	0.7	314.2	0.0	29.1	0.	0.	0.0	0.0	0.0
42	0.1	39.8	0.0	0.5	0.	0.	0.0	0.0	0.0
43	0.6	211.5	0.0	0.0	0.	0.	0.0	0.0	0.0
44	0.7	195.1	0.0	0.0	0.	0.	0.0	0.0	0.0
45	0.6	140.8	0.0	0.0	0.	0.	0.0	0.0	0.0
46	0.6	88.5	0.0	0.0	0.	0.	0.0	0.0	0.0
47	0.6	38.4	0.0	0.0	0.	0.	0.0	0.0	0.0
48	0.2	2.1	0.0	0.0	0.	0.	0.0	0.0	0.0

```
                         *** GSTABL7 ***
              ** GSTABL7 by Garry H. Gregory, P.E. **
  ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
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*********************************************************************************
                  SLOPE STABILITY ANALYSIS SYSTEM
     Modified Bishop, Simplified Janbu, or GLE Method of Slices.
     (Includes Spencer & Morgenstern-Price Type Analysis)
     Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
     Nonlinear Undrained Shear Strength, Curved Phi Envelope,
     Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
     Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*********************************************************************************
Analysis Run Date:        12/15/2008
Time of Run:              01:40PM
Run By:                   Alan Taylor
Input Data Filename:      C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engi
neering\Alton Revised\alton line ff sp-16-13 static.in
Output Filename:          C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engi
neering\Alton Revised\alton line ff sp-16-13 static.OUT
Unit System:              English
Plotted Output Filename:  C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engi
neering\Alton Revised\alton line ff sp-16-13 static.PLT
PROBLEM DESCRIPTION:  Alton Coal Hollow Sedimentation Pond 4:
                      Line FF, Soil SP-16-13 - Seismic
BOUNDARY COORDINATES
    4 Top   Boundaries
    4 Total Boundaries
Boundary    X-Left     Y-Left     X-Right    Y-Right    Soil Type
   No.       (ft)       (ft)       (ft)       (ft)      Below Bnd
    1         0.00     6823.00      20.00    6823.00        1
    2        20.00     6823.00      50.00    6838.00        1
    3        50.00     6838.00      62.00    6838.00        1
    4        62.00     6838.00      82.00    6828.00        1
User Specified Y-Origin =      6750.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
  2 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore    Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept  Angle   Pressure  Constant  Surface
 No.  (pcf)    (pcf)     (psf)    (deg)    Param.    (psf)      No.
  1    99.4    116.2      94.0     29.6     0.00      0.0        1
  2   105.0    110.0      90.0     29.0     0.00      0.0        1
1 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  6 Coordinate Points
Pore Pressure Inclination Factor =  0.50
  Point      X-Water    Y-Water
   No.        (ft)       (ft)
    1         0.00     6834.00
    2        20.00     6834.00
    3        42.00     6834.00
    4        50.00     6834.00
    5        58.00     6834.00
    6        82.00     6828.00
Specified Peak Ground Acceleration Coefficient (A) =   0.291(g)
Specified Horizontal Earthquake Coefficient (kh) =   0.145(g)
Specified Vertical Earthquake Coefficient (kv) =   0.000(g)
Specified Seismic Pore-Pressure Factor =   0.000
A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
 400 Trial Surfaces Have Been Generated.
  20 Surface(s) Initiate(s) From Each Of    20 Points Equally Spaced
Along The Ground Surface Between  X =   10.00(ft)
                             and  X =   45.00(ft)
Each Surface Terminates Between   X =   48.00(ft)
                             and  X =   60.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is  Y =   6700.00(ft)
```

1.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Evaluated. They Are
Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 400
Number of Trial Surfaces With Valid FS = 400
Statistical Data On All Valid FS Values:
FS Max = 9.224 FS Min = 1.309 FS Ave = 2.052
Standard Deviation = 0.881 Coefficient of Variation = 42.94 %
Failure Surface Specified By 45 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	19.211	6823.000
2	20.192	6822.808
3	21.178	6822.642
4	22.168	6822.503
5	23.162	6822.391
6	24.158	6822.305
7	25.157	6822.246
8	26.156	6822.213
9	27.156	6822.208
10	28.156	6822.230
11	29.155	6822.279
12	30.152	6822.354
13	31.147	6822.457
14	32.138	6822.585
15	33.126	6822.741
16	34.109	6822.923
17	35.087	6823.132
18	36.059	6823.367
19	37.025	6823.627
20	37.983	6823.914
21	38.933	6824.227
22	39.874	6824.564
23	40.806	6824.927
24	41.728	6825.315
25	42.638	6825.728
26	43.538	6826.165
27	44.425	6826.625
28	45.300	6827.110
29	46.162	6827.618
30	47.009	6828.148
31	47.842	6828.702
32	48.659	6829.278
33	49.461	6829.875
34	50.247	6830.494
35	51.015	6831.134
36	51.766	6831.794
37	52.500	6832.474
38	53.214	6833.174
39	53.909	6833.893
40	54.585	6834.629
41	55.241	6835.384
42	55.876	6836.157
43	56.491	6836.946
44	57.083	6837.751
45	57.257	6838.000

Circle Center At X = 26.846 ; Y = 6859.390 ; and Radius = 37.182
Factor of Safety
*** 1.309 ***
Individual data on the 48 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	0.8	7.1	541.9	556.1	0.	0.	1.0	0.0	0.0
2	0.2	4.9	146.6	136.3	0.	0.	0.7	0.0	0.0
3	1.0	70.7	733.3	703.5	0.	0.	10.3	0.0	0.0
4	1.0	145.4	702.2	713.1	0.	0.	21.1	0.0	0.0

5	1.0	217.7	670.2	720.9	0.	0.	31.6	0.0	0.0
6	1.0	287.4	637.4	727.1	0.	0.	41.7	0.0	0.0
7	1.0	354.2	603.9	731.6	0.	0.	51.4	0.0	0.0
8	1.0	417.9	569.8	734.5	0.	0.	60.6	0.0	0.0
9	1.0	478.4	535.2	735.6	0.	0.	69.4	0.0	0.0
10	1.0	535.5	500.2	735.2	0.	0.	77.6	0.0	0.0
11	1.0	588.8	464.9	732.9	0.	0.	85.4	0.0	0.0
12	1.0	638.5	429.5	729.1	0.	0.	92.6	0.0	0.0
13	1.0	684.2	393.9	723.5	0.	0.	99.2	0.0	0.0
14	1.0	726.0	358.3	716.3	0.	0.	105.3	0.0	0.0
15	1.0	763.6	322.8	707.4	0.	0.	110.7	0.0	0.0
16	1.0	797.1	287.5	696.9	0.	0.	115.6	0.0	0.0
17	1.0	826.4	252.5	684.7	0.	0.	119.8	0.0	0.0
18	1.0	851.4	217.9	670.9	0.	0.	123.5	0.0	0.0
19	1.0	872.1	183.8	655.4	0.	0.	126.5	0.0	0.0
20	1.0	888.5	150.3	638.3	0.	0.	128.8	0.0	0.0
21	0.9	900.6	117.4	619.7	0.	0.	130.6	0.0	0.0
22	0.9	908.5	85.3	599.4	0.	0.	131.7	0.0	0.0
23	0.9	912.1	54.0	577.4	0.	0.	132.3	0.0	0.0
24	0.9	911.7	23.6	554.0	0.	0.	132.2	0.0	0.0
25	0.3	270.9	1.3	161.0	0.	0.	39.3	0.0	0.0
26	0.6	634.6	0.0	368.1	0.	0.	92.0	0.0	0.0
27	0.9	890.5	0.0	502.6	0.	0.	129.1	0.0	0.0
28	0.9	871.6	0.0	474.6	0.	0.	126.4	0.0	0.0
29	0.9	849.4	0.0	445.0	0.	0.	123.2	0.0	0.0
30	0.9	823.9	0.0	414.1	0.	0.	119.5	0.0	0.0
31	0.8	795.5	0.0	381.7	0.	0.	115.3	0.0	0.0
32	0.8	764.1	0.0	347.9	0.	0.	110.8	0.0	0.0
33	0.8	730.0	0.0	312.6	0.	0.	105.8	0.0	0.0
34	0.8	693.5	0.0	276.0	0.	0.	100.6	0.0	0.0
35	0.5	451.9	0.0	167.4	0.	0.	65.5	0.0	0.0
36	0.2	201.5	0.0	70.6	0.	0.	29.2	0.0	0.0
37	0.8	590.1	0.0	198.8	0.	0.	85.6	0.0	0.0
38	0.8	520.0	0.0	158.3	0.	0.	75.4	0.0	0.0
39	0.7	450.4	0.0	116.5	0.	0.	65.3	0.0	0.0
40	0.7	381.7	0.0	73.4	0.	0.	55.4	0.0	0.0
41	0.7	314.2	0.0	29.1	0.	0.	45.6	0.0	0.0
42	0.1	39.8	0.0	0.5	0.	0.	5.8	0.0	0.0
43	0.6	211.5	0.0	0.0	0.	0.	30.7	0.0	0.0
44	0.7	195.1	0.0	0.0	0.	0.	28.3	0.0	0.0
45	0.6	140.8	0.0	0.0	0.	0.	20.4	0.0	0.0
46	0.6	88.5	0.0	0.0	0.	0.	12.8	0.0	0.0
47	0.6	38.4	0.0	0.0	0.	0.	5.6	0.0	0.0
48	0.2	2.1	0.0	0.0	0.	0.	0.3	0.0	0.0

*** **GSTABL7** ***

** GSTABL7 by Garry H. Gregory, P.E. **

** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **

****

SLOPE STABILITY ANALYSIS SYSTEM

Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.

****

Analysis Run Date: 12/15/2008
Time of Run: 01:31PM
Run By: Alan Taylor
Input Data Filename: C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engineering\Alton Revised\alton line ff sp-16-13 rapid drawdown stage 1.in
Output Filename: C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engineering\Alton Revised\alton line ff sp-16-13 rapid drawdown stage 1.OUT
Unit System: English
Plotted Output Filename: C:\Documents and Settings\Owner\My Documents\Taylor Geo-Engineering\Alton Revised\alton line ff sp-16-13 rapid drawdown stage 1.PLT
PROBLEM DESCRIPTION: Alton Coal Hollow Sedimentation Pond 4:
Line FF, Soil SP-16-13 - Rapid Drawdown

BOUNDARY COORDINATES
4 Top Boundaries
4 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	6823.00	20.00	6823.00	1
2	20.00	6823.00	50.00	6838.00	1
3	50.00	6838.00	62.00	6838.00	1
4	62.00	6838.00	82.00	6828.00	1

User Specified Y-Origin = 6750.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)

ISOTROPIC SOIL PARAMETERS
2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	99.4	116.2	84.0	16.0	0.00	0.0	1
2	105.0	110.0	90.0	29.0	0.00	0.0	1

1 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water = 62.40 (pcf)
Piezometric Surface No. 1 Specified by 6 Coordinate Points
Pore Pressure Inclination Factor = 0.50

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	6834.00
2	20.00	6834.00
3	42.00	6834.00
4	50.00	6838.00
5	58.00	6834.00
6	82.00	6828.00

WATER SURFACE DATA HAS BEEN SUPPRESSED
Specified Peak Ground Acceleration Coefficient (A) = 0.291(g)
Specified Horizontal Earthquake Coefficient (kh) = 0.145(g)
Specified Vertical Earthquake Coefficient (kv) = 0.000(g)
Specified Seismic Pore-Pressure Factor = 0.000
EARTHQUAKE DATA HAS BEEN SUPPRESSED
A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
400 Trial Surfaces Have Been Generated.
20 Surface(s) Initiate(s) From Each Of 20 Points Equally Spaced
Along The Ground Surface Between X = 10.00(ft)
and X = 45.00(ft)
Each Surface Terminates Between X = 48.00(ft)

and X = 60.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 6700.00(ft)
1.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Evaluated. They Are
Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 400
Number of Trial Surfaces With Valid FS = 400
Statistical Data On All Valid FS Values:
FS Max = 10.260 FS Min = 1.245 FS Ave = 2.090
Standard Deviation = 1.077 Coefficient of Variation = 51.53 %
Failure Surface Specified By 45 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	19.211	6823.000
2	20.192	6822.808
3	21.178	6822.642
4	22.168	6822.503
5	23.162	6822.391
6	24.158	6822.305
7	25.157	6822.246
8	26.156	6822.213
9	27.156	6822.208
10	28.156	6822.230
11	29.155	6822.279
12	30.152	6822.354
13	31.147	6822.457
14	32.138	6822.585
15	33.126	6822.741
16	34.109	6822.923
17	35.087	6823.132
18	36.059	6823.367
19	37.025	6823.627
20	37.983	6823.914
21	38.933	6824.227
22	39.874	6824.564
23	40.806	6824.927
24	41.728	6825.315
25	42.638	6825.728
26	43.538	6826.165
27	44.425	6826.625
28	45.300	6827.110
29	46.162	6827.618
30	47.009	6828.148
31	47.842	6828.702
32	48.659	6829.278
33	49.461	6829.875
34	50.247	6830.494
35	51.015	6831.134
36	51.766	6831.794
37	52.500	6832.474
38	53.214	6833.174
39	53.909	6833.893
40	54.585	6834.629
41	55.241	6835.384
42	55.876	6836.157
43	56.491	6836.946
44	57.083	6837.751
45	57.257	6838.000

Circle Center At X = 26.846 ; Y = 6859.390 ; and Radius = 37.182
Factor of Safety
*** 1.245 ***
Individual data on the 46 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	0.8	6.1	0.0	0.0	0.	0.	0.0	0.0	0.0

2	0.2	4.2	0.0	0.0	0.	0.	0.0	0.0	0.0
3	1.0	60.5	0.0	0.0	0.	0.	0.0	0.0	0.0
4	1.0	124.4	0.0	0.0	0.	0.	0.0	0.0	0.0
5	1.0	186.3	0.0	0.0	0.	0.	0.0	0.0	0.0
6	1.0	245.8	0.0	0.0	0.	0.	0.0	0.0	0.0
7	1.0	303.0	0.0	0.0	0.	0.	0.0	0.0	0.0
8	1.0	357.5	0.0	0.0	0.	0.	0.0	0.0	0.0
9	1.0	409.2	0.0	0.0	0.	0.	0.0	0.0	0.0
10	1.0	458.1	0.0	0.0	0.	0.	0.0	0.0	0.0
11	1.0	503.7	0.0	0.0	0.	0.	0.0	0.0	0.0
12	1.0	546.2	0.0	0.0	0.	0.	0.0	0.0	0.0
13	1.0	585.3	0.0	0.0	0.	0.	0.0	0.0	0.0
14	1.0	621.0	0.0	0.0	0.	0.	0.0	0.0	0.0
15	1.0	653.2	0.0	0.0	0.	0.	0.0	0.0	0.0
16	1.0	681.9	0.0	0.0	0.	0.	0.0	0.0	0.0
17	1.0	706.9	0.0	0.0	0.	0.	0.0	0.0	0.0
18	1.0	728.3	0.0	0.0	0.	0.	0.0	0.0	0.0
19	1.0	746.0	0.0	0.0	0.	0.	0.0	0.0	0.0
20	1.0	760.0	0.0	0.0	0.	0.	0.0	0.0	0.0
21	0.9	770.4	0.0	0.0	0.	0.	0.0	0.0	0.0
22	0.9	777.1	0.0	0.0	0.	0.	0.0	0.0	0.0
23	0.9	780.2	0.0	0.0	0.	0.	0.0	0.0	0.0
24	0.9	779.9	0.0	0.0	0.	0.	0.0	0.0	0.0
25	0.9	776.0	0.0	0.0	0.	0.	0.0	0.0	0.0
26	0.9	768.7	0.0	0.0	0.	0.	0.0	0.0	0.0
27	0.9	758.2	0.0	0.0	0.	0.	0.0	0.0	0.0
28	0.9	744.6	0.0	0.0	0.	0.	0.0	0.0	0.0
29	0.9	727.9	0.0	0.0	0.	0.	0.0	0.0	0.0
30	0.8	708.4	0.0	0.0	0.	0.	0.0	0.0	0.0
31	0.8	686.1	0.0	0.0	0.	0.	0.0	0.0	0.0
32	0.8	661.2	0.0	0.0	0.	0.	0.0	0.0	0.0
33	0.8	633.9	0.0	0.0	0.	0.	0.0	0.0	0.0
34	0.5	416.5	0.0	0.0	0.	0.	0.0	0.0	0.0
35	0.2	186.5	0.0	0.0	0.	0.	0.0	0.0	0.0
36	0.8	549.0	0.0	0.0	0.	0.	0.0	0.0	0.0
37	0.8	488.0	0.0	0.0	0.	0.	0.0	0.0	0.0
38	0.7	427.4	0.0	0.0	0.	0.	0.0	0.0	0.0
39	0.7	367.6	0.0	0.0	0.	0.	0.0	0.0	0.0
40	0.7	308.8	0.0	0.0	0.	0.	0.0	0.0	0.0
41	0.7	251.2	0.0	0.0	0.	0.	0.0	0.0	0.0
42	0.7	195.1	0.0	0.0	0.	0.	0.0	0.0	0.0
43	0.6	140.8	0.0	0.0	0.	0.	0.0	0.0	0.0
44	0.6	88.5	0.0	0.0	0.	0.	0.0	0.0	0.0
45	0.6	38.4	0.0	0.0	0.	0.	0.0	0.0	0.0
46	0.2	2.1	0.0	0.0	0.	0.	0.0	0.0	0.0

APPENDIX E-6

OUPTUT FILES OF STATIC AND PSEUDO-STATIC SLOPE STABILITY ANALYSES

LINE E-E, Sedimentation Pond #3

***** GSTABL7 *****

** GSTABL7 by Garry H. Gregory, P.E. **
** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **

****

SLOPE STABILITY ANALYSIS SYSTEM
Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.

****

Analysis Run Date: 12/15/2008
Time of Run: 01:45PM
Run By: Alan Taylor
Input Data Filename: f:\alton line ee gt-5.in
Output Filename: f:\alton line ee gt-5.OUT
Unit System: English
Plotted Output Filename: f:\alton line ee gt-5.PLT
PROBLEM DESCRIPTION: Alton Coal Hollow Sedimentation Pond 3:
Line E-E, Soil GT-5 - Static

BOUNDARY COORDINATES
5 Top Boundaries
5 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	6800.00	20.00	6800.00	1
2	20.00	6800.00	29.00	6804.00	1
3	29.00	6804.00	48.00	6814.00	1
4	48.00	6814.00	60.00	6814.00	1
5	60.00	6814.00	80.00	6804.00	1

User Specified Y-Origin = 6750.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)

ISOTROPIC SOIL PARAMETERS
1 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	100.0	120.0	700.0	10.0	0.00	0.0	1

1 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water = 62.40 (pcf)
Piezometric Surface No. 1 Specified by 5 Coordinate Points
Pore Pressure Inclination Factor = 0.50

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	6810.00
2	20.00	6810.00
3	42.00	6810.00
4	60.00	6807.00
5	80.00	6803.00

Specified Peak Ground Acceleration Coefficient (A) = 0.291(g)
Specified Horizontal Earthquake Coefficient (kh) = 0.145(g)
Specified Vertical Earthquake Coefficient (kv) = 0.000(g)
Specified Seismic Pore-Pressure Factor = 0.000
EARTHQUAKE DATA HAS BEEN SUPPRESSED
A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
400 Trial Surfaces Have Been Generated.
20 Surface(s) Initiate(s) From Each Of 20 Points Equally Spaced
Along The Ground Surface Between X = 5.00(ft)
and X = 25.00(ft)
Each Surface Terminates Between X = 48.00(ft)
and X = 60.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 6700.00(ft)
2.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial

Failure Surfaces Evaluated. They Are
Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 400
Number of Trial Surfaces With Valid FS = 400
Statistical Data On All Valid FS Values:
FS Max = 19.860 FS Min = 5.298 FS Ave = 6.609
Standard Deviation = 1.849 Coefficient of Variation = 27.98 %
Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	17.632	6800.000
2	19.292	6798.885
3	21.030	6797.895
4	22.834	6797.033
5	24.697	6796.304
6	26.608	6795.713
7	28.556	6795.263
8	30.533	6794.956
9	32.526	6794.792
10	34.526	6794.775
11	36.522	6794.903
12	38.503	6795.176
13	40.459	6795.592
14	42.380	6796.149
15	44.255	6796.845
16	46.075	6797.675
17	47.829	6798.636
18	49.509	6799.721
19	51.105	6800.926
20	52.610	6802.244
21	54.015	6803.667
22	55.312	6805.189
23	56.496	6806.801
24	57.559	6808.496
25	58.496	6810.263
26	59.301	6812.093
27	59.972	6813.978
28	59.978	6814.000

Circle Center At X = 33.766 ; Y = 6822.242 ; and Radius = 27.477
Factor of Safety
*** 5.298 ***
Individual data on the 32 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	1.7	111.1	1036.2	1317.7	0.	0.	0.0	0.0	0.0
2	0.7	111.8	441.7	575.4	0.	0.	0.0	0.0	0.0
3	1.0	252.2	686.9	873.5	0.	0.	0.0	0.0	0.0
4	1.8	735.2	1126.6	1564.5	0.	0.	0.0	0.0	0.0
5	1.9	1118.8	1059.0	1663.8	0.	0.	0.0	0.0	0.0
6	1.9	1491.1	977.0	1746.1	0.	0.	0.0	0.0	0.0
7	1.9	1842.9	882.3	1811.0	0.	0.	0.0	0.0	0.0
8	0.4	461.8	184.8	413.9	0.	0.	0.0	0.0	0.0
9	1.5	1715.6	604.8	1444.5	0.	0.	0.0	0.0	0.0
10	2.0	2501.4	656.3	1887.7	0.	0.	0.0	0.0	0.0
11	2.0	2783.4	510.3	1899.0	0.	0.	0.0	0.0	0.0
12	2.0	3016.5	361.2	1892.1	0.	0.	0.0	0.0	0.0
13	2.0	3195.7	212.4	1867.1	0.	0.	0.0	0.0	0.0
14	2.0	3317.6	66.7	1824.1	0.	0.	0.0	0.0	0.0
15	1.5	2689.9	0.0	1420.1	0.	0.	0.0	0.0	0.0
16	0.4	668.2	0.0	337.9	0.	0.	0.0	0.0	0.0
17	1.9	3311.3	0.0	1635.4	0.	0.	0.0	0.0	0.0
18	1.8	3212.8	0.0	1503.5	0.	0.	0.0	0.0	0.0
19	1.8	3064.3	0.0	1356.7	0.	0.	0.0	0.0	0.0
20	0.2	295.9	0.0	129.4	0.	0.	0.0	0.0	0.0
21	1.5	2514.9	0.0	1066.0	0.	0.	0.0	0.0	0.0
22	1.6	2444.6	0.0	1020.8	0.	0.	0.0	0.0	0.0
23	1.5	2069.0	0.0	833.8	0.	0.	0.0	0.0	0.0

24	1.4	1694.6	0.0	635.2	0.	0.	0.0	0.0	0.0
25	1.3	1330.6	0.0	426.2	0.	0.	0.0	0.0	0.0
26	1.2	986.7	0.0	207.7	0.	0.	0.0	0.0	0.0
27	0.4	307.7	0.0	20.1	0.	0.	0.0	0.0	0.0
28	0.6	370.8	0.0	0.0	0.	0.	0.0	0.0	0.0
29	0.9	432.9	0.0	0.0	0.	0.	0.0	0.0	0.0
30	0.8	227.5	0.0	0.0	0.	0.	0.0	0.0	0.0
31	0.7	64.7	0.0	0.0	0.	0.	0.0	0.0	0.0
32	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 27 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	17.632	6800.000
2	19.320	6798.928
3	21.080	6797.979
4	22.904	6797.157
5	24.781	6796.468
6	26.703	6795.915
7	28.660	6795.500
8	30.641	6795.227
9	32.637	6795.095
10	34.637	6795.105
11	36.631	6795.259
12	38.609	6795.554
13	40.561	6795.990
14	42.477	6796.563
15	44.347	6797.272
16	46.162	6798.113
17	47.912	6799.081
18	49.589	6800.171
19	51.183	6801.378
20	52.688	6802.696
21	54.094	6804.118
22	55.396	6805.636
23	56.586	6807.244
24	57.658	6808.932
25	58.607	6810.692
26	59.428	6812.516
27	59.973	6814.000

Circle Center At X = 33.487 ; Y = 6823.099 ; and Radius = 28.017

Factor of Safety

*** 5.302 ***

***** GSTABL7 *****

** GSTABL7 by Garry H. Gregory, P.E. **
** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **

****

SLOPE STABILITY ANALYSIS SYSTEM
Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.

****

Analysis Run Date: 12/15/2008
Time of Run: 01:50PM
Run By: Alan Taylor
Input Data Filename: f:\alton line ee gt-5.in
Output Filename: f:\alton line ee gt-5.OUT
Unit System: English
Plotted Output Filename: f:\alton line ee gt-5.PLT
PROBLEM DESCRIPTION: Alton Coal Hollow Sedimentation Pond 3:
Line E-E, Soil GT-5 - Seismic

BOUNDARY COORDINATES
5 Top Boundaries
5 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	6800.00	20.00	6800.00	1
2	20.00	6800.00	29.00	6804.00	1
3	29.00	6804.00	48.00	6814.00	1
4	48.00	6814.00	60.00	6814.00	1
5	60.00	6814.00	80.00	6804.00	1

User Specified Y-Origin = 6750.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)

ISOTROPIC SOIL PARAMETERS
1 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	100.0	120.0	700.0	10.0	0.00	0.0	1

1 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water = 62.40 (pcf)
Piezometric Surface No. 1 Specified by 5 Coordinate Points
Pore Pressure Inclination Factor = 0.50

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	6810.00
2	20.00	6810.00
3	42.00	6810.00
4	60.00	6807.00
5	80.00	6803.00

Specified Peak Ground Acceleration Coefficient (A) = 0.291(g)
Specified Horizontal Earthquake Coefficient (kh) = 0.145(g)
Specified Vertical Earthquake Coefficient (kv) = 0.000(g)
Specified Seismic Pore-Pressure Factor = 0.000
A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
400 Trial Surfaces Have Been Generated.
20 Surface(s) Initiate(s) From Each Of 20 Points Equally Spaced
Along The Ground Surface Between X = 15.00(ft)
and X = 25.00(ft)
Each Surface Terminates Between X = 48.00(ft)
and X = 60.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 6700.00(ft)
2.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Evaluated. They Are

Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 400
Number of Trial Surfaces With Valid FS = 400
Statistical Data On All Valid FS Values:
FS Max = 13.678 FS Min = 3.252 FS Ave = 4.176
Standard Deviation = 1.334 Coefficient of Variation = 31.95 %
Failure Surface Specified By 30 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	15.000	6800.000
2	16.469	6798.643
3	18.036	6797.400
4	19.692	6796.278
5	21.427	6795.283
6	23.232	6794.422
7	25.096	6793.698
8	27.010	6793.117
9	28.962	6792.680
10	30.941	6792.391
11	32.936	6792.251
12	34.936	6792.262
13	36.929	6792.422
14	38.905	6792.732
15	40.852	6793.189
16	42.760	6793.791
17	44.617	6794.534
18	46.412	6795.414
19	48.137	6796.427
20	49.781	6797.566
21	51.335	6798.825
22	52.790	6800.197
23	54.138	6801.675
24	55.372	6803.249
25	56.483	6804.912
26	57.467	6806.653
27	58.318	6808.463
28	59.030	6810.332
29	59.600	6812.249
30	59.981	6814.000

Circle Center At X = 33.795 ; Y = 6818.872 ; and Radius = 26.635
Factor of Safety
*** 3.252 ***
Individual data on the 34 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	1.5	119.7	916.8	1332.7	0.	0.	17.4	0.0	0.0
2	1.6	372.0	977.7	1495.0	0.	0.	53.9	0.0	0.0
3	1.7	628.1	1033.2	1642.6	0.	0.	91.1	0.0	0.0
4	0.3	140.9	192.3	306.1	0.	0.	20.4	0.0	0.0
5	1.4	791.9	943.6	1468.5	0.	0.	114.8	0.0	0.0
6	1.8	1339.1	1104.9	1890.3	0.	0.	194.2	0.0	0.0
7	1.9	1743.0	1037.6	1989.3	0.	0.	252.7	0.0	0.0
8	1.9	2131.5	955.1	2070.6	0.	0.	309.1	0.0	0.0
9	2.0	2494.6	859.7	2134.3	0.	0.	361.7	0.0	0.0
10	0.0	52.0	15.7	41.8	0.	0.	7.5	0.0	0.0
11	1.9	2789.5	751.2	2137.8	0.	0.	404.5	0.0	0.0
12	2.0	3166.3	626.6	2206.3	0.	0.	459.1	0.0	0.0
13	2.0	3441.8	479.8	2214.3	0.	0.	499.1	0.0	0.0
14	2.0	3661.8	330.5	2203.7	0.	0.	531.0	0.0	0.0
15	2.0	3821.3	182.1	2174.4	0.	0.	554.1	0.0	0.0
16	1.9	3917.2	37.7	2126.6	0.	0.	568.0	0.0	0.0
17	1.1	2352.1	0.0	1248.7	0.	0.	341.1	0.0	0.0
18	0.8	1563.6	0.0	797.7	0.	0.	226.7	0.0	0.0
19	1.9	3832.1	0.0	1915.2	0.	0.	555.7	0.0	0.0
20	1.8	3693.5	0.0	1777.8	0.	0.	535.6	0.0	0.0
21	1.6	3225.3	0.0	1501.8	0.	0.	467.7	0.0	0.0
22	0.1	275.9	0.0	123.5	0.	0.	40.0	0.0	0.0

23	1.6	3179.5	0.0	1458.2	0.	0.	461.0	0.0	0.0
24	1.6	2774.0	0.0	1277.8	0.	0.	402.2	0.0	0.0
25	1.5	2361.1	0.0	1084.8	0.	0.	342.4	0.0	0.0
26	1.3	1951.3	0.0	880.7	0.	0.	282.9	0.0	0.0
27	1.2	1554.8	0.0	666.2	0.	0.	225.4	0.0	0.0
28	1.1	1181.7	0.0	443.0	0.	0.	171.4	0.0	0.0
29	1.0	842.0	0.0	212.0	0.	0.	122.1	0.0	0.0
30	0.3	236.9	0.0	18.7	0.	0.	34.3	0.0	0.0
31	0.5	313.6	0.0	0.0	0.	0.	45.5	0.0	0.0
32	0.7	327.9	0.0	0.0	0.	0.	47.5	0.0	0.0
33	0.6	154.5	0.0	0.0	0.	0.	22.4	0.0	0.0
34	0.4	33.3	0.0	0.0	0.	0.	4.8	0.0	0.0

Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	16.053	6800.000
2	17.577	6798.706
3	19.195	6797.530
4	20.898	6796.480
5	22.675	6795.562
6	24.516	6794.781
7	26.410	6794.141
8	28.348	6793.646
9	30.318	6793.298
10	32.308	6793.101
11	34.307	6793.055
12	36.305	6793.159
13	38.288	6793.415
14	40.247	6793.819
15	42.170	6794.370
16	44.045	6795.065
17	45.862	6795.899
18	47.612	6796.869
19	49.283	6797.968
20	50.866	6799.190
21	52.352	6800.529
22	53.733	6801.976
23	55.001	6803.522
24	56.148	6805.161
25	57.169	6806.881
26	58.056	6808.673
27	58.805	6810.528
28	59.413	6812.434
29	59.784	6814.000

Circle Center At X = 33.922 ; Y = 6819.504 ; and Radius = 26.452

Factor of Safety
*** 3.264 ***

```
                         *** GSTABL7 ***
                ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
            (All Rights Reserved-Unauthorized Use Prohibited)
*********************************************************************************
                     SLOPE STABILITY ANALYSIS SYSTEM
       Modified Bishop, Simplified Janbu, or GLE Method of Slices.
       (Includes Spencer & Morgenstern-Price Type Analysis)
       Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
       Nonlinear Undrained Shear Strength, Curved Phi Envelope,
       Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
       Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*********************************************************************************
Analysis Run Date:         12/15/2008
Time of Run:               02:01PM
Run By:                    Alan Taylor
Input Data Filename:       f:\line ee rapid drawdown.in
Output Filename:           f:\line ee rapid drawdown.OUT
Unit System:               English
Plotted Output Filename:   f:\line ee rapid drawdown.PLT
PROBLEM DESCRIPTION:  Alton Coal Hollow Sedimentation Pond 3:
                      Line E-E, Soil GT-5 - Rapid Drawdown
BOUNDARY COORDINATES
    5 Top   Boundaries
    5 Total Boundaries
Boundary     X-Left     Y-Left     X-Right     Y-Right     Soil Type
   No.        (ft)       (ft)        (ft)        (ft)       Below Bnd
    1         0.00     6800.00      20.00      6800.00         1
    2        20.00     6800.00      29.00      6804.00         1
    3        29.00     6804.00      48.00      6814.00         1
    4        48.00     6814.00      60.00      6814.00         1
    5        60.00     6814.00      80.00      6804.00         1
User Specified Y-Origin =      6750.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
 1 Type(s) of Soil
Soil  Total  Saturated  Cohesion Friction   Pore    Pressure   Piez.
Type Unit Wt. Unit Wt. Intercept  Angle   Pressure Constant  Surface
 No.   (pcf)    (pcf)     (psf)    (deg)    Param.    (psf)     No.
  1   100.0    120.0     300.0     8.0     0.00       0.0       1
1 PIEZOMETRIC SURFACE(S) SPECIFIED
Unit Weight of Water =  62.40 (pcf)
Piezometric Surface No.  1 Specified by  5 Coordinate Points
Pore Pressure Inclination Factor =  0.50
  Point      X-Water     Y-Water
   No.         (ft)        (ft)
    1          0.00      6810.00
    2         40.00      6810.00
    3         48.00      6814.00
    4         60.00      6810.00
    5         80.00      6803.00
WATER SURFACE DATA HAS BEEN SUPPRESSED
Specified Peak Ground Acceleration Coefficient (A) =   0.291(g)
Specified Horizontal Earthquake Coefficient (kh) =   0.145(g)
Specified Vertical Earthquake Coefficient (kv) =   0.000(g)
Specified Seismic Pore-Pressure Factor =   0.000
EARTHQUAKE DATA HAS BEEN SUPPRESSED
A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
 400 Trial Surfaces Have Been Generated.
  20 Surface(s) Initiate(s) From Each Of    20 Points Equally Spaced
Along The Ground Surface Between  X =    5.00(ft)
                             and  X =   35.00(ft)
Each Surface Terminates Between   X =   48.00(ft)
                             and  X =   60.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is  Y =   6700.00(ft)
 2.00(ft) Line Segments Define Each Trial Failure Surface.
```

Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Evaluated. They Are
Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 400
Number of Trial Surfaces With Valid FS = 400
Statistical Data On All Valid FS Values:
FS Max = 7.789 FS Min = 1.916 FS Ave = 2.640
Standard Deviation = 0.930 Coefficient of Variation = 35.22 %
Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	16.053	6800.000
2	17.769	6798.973
3	19.550	6798.063
4	21.388	6797.275
5	23.275	6796.611
6	25.201	6796.075
7	27.160	6795.668
8	29.141	6795.394
9	31.136	6795.253
10	33.136	6795.246
11	35.132	6795.372
12	37.115	6795.631
13	39.076	6796.023
14	41.007	6796.545
15	42.898	6797.195
16	44.742	6797.970
17	46.530	6798.866
18	48.254	6799.880
19	49.906	6801.007
20	51.480	6802.242
21	52.967	6803.580
22	54.361	6805.014
23	55.656	6806.538
24	56.847	6808.145
25	57.927	6809.828
26	58.892	6811.579
27	59.739	6813.391
28	59.975	6814.000

Circle Center At X = 32.244 ; Y = 6825.100 ; and Radius = 29.869
Factor of Safety
*** 1.916 ***
Individual data on the 30 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	1.7	88.2	0.0	0.0	0.	0.	0.0	0.0	0.0
2	1.8	264.0	0.0	0.0	0.	0.	0.0	0.0	0.0
3	0.4	91.5	0.0	0.0	0.	0.	0.0	0.0	0.0
4	1.4	379.8	0.0	0.0	0.	0.	0.0	0.0	0.0
5	1.9	772.2	0.0	0.0	0.	0.	0.0	0.0	0.0
6	1.9	1067.6	0.0	0.0	0.	0.	0.0	0.0	0.0
7	2.0	1346.4	0.0	0.0	0.	0.	0.0	0.0	0.0
8	1.8	1481.3	0.0	0.0	0.	0.	0.0	0.0	0.0
9	0.1	121.6	0.0	0.0	0.	0.	0.0	0.0	0.0
10	2.0	1850.5	0.0	0.0	0.	0.	0.0	0.0	0.0
11	2.0	2080.3	0.0	0.0	0.	0.	0.0	0.0	0.0
12	2.0	2274.1	0.0	0.0	0.	0.	0.0	0.0	0.0
13	2.0	2428.7	0.0	0.0	0.	0.	0.0	0.0	0.0
14	2.0	2541.8	0.0	0.0	0.	0.	0.0	0.0	0.0
15	1.9	2611.8	0.0	0.0	0.	0.	0.0	0.0	0.0
16	1.9	2638.1	0.0	0.0	0.	0.	0.0	0.0	0.0
17	1.8	2621.6	0.0	0.0	0.	0.	0.0	0.0	0.0
18	1.8	2563.4	0.0	0.0	0.	0.	0.0	0.0	0.0
19	1.5	2104.0	0.0	0.0	0.	0.	0.0	0.0	0.0
20	0.3	360.7	0.0	0.0	0.	0.	0.0	0.0	0.0
21	1.7	2239.8	0.0	0.0	0.	0.	0.0	0.0	0.0
22	1.6	1946.8	0.0	0.0	0.	0.	0.0	0.0	0.0

23	1.5	1649.0	0.0	0.0	0.	0.	0.0	0.0	0.0
24	1.4	1352.9	0.0	0.0	0.	0.	0.0	0.0	0.0
25	1.3	1065.3	0.0	0.0	0.	0.	0.0	0.0	0.0
26	1.2	792.8	0.0	0.0	0.	0.	0.0	0.0	0.0
27	1.1	541.7	0.0	0.0	0.	0.	0.0	0.0	0.0
28	1.0	318.2	0.0	0.0	0.	0.	0.0	0.0	0.0
29	0.8	128.2	0.0	0.0	0.	0.	0.0	0.0	0.0
30	0.2	7.2	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 30 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	12.895	6800.000
2	14.529	6798.846
3	16.234	6797.802
4	18.005	6796.873
5	19.833	6796.061
6	21.710	6795.371
7	23.628	6794.806
8	25.580	6794.367
9	27.556	6794.058
10	29.548	6793.878
11	31.547	6793.830
12	33.545	6793.913
13	35.534	6794.126
14	37.504	6794.470
15	39.448	6794.942
16	41.356	6795.541
17	43.221	6796.263
18	45.035	6797.106
19	46.789	6798.066
20	48.477	6799.139
21	50.091	6800.321
22	51.623	6801.605
23	53.069	6802.988
24	54.420	6804.462
25	55.672	6806.021
26	56.819	6807.660
27	57.856	6809.370
28	58.779	6811.145
29	59.583	6812.976
30	59.955	6814.000

Circle Center At X = 31.280 ; Y = 6824.292 ; and Radius = 30.465

Factor of Safety

*** 1.919 ***

APPENDIX F

RECOMMENDED EARTHWORK SPECIFICATIONS

APPENDIX F
RECOMMENDED EARTHWORK SPECIFICATIONS

1. Areas to receive fill and/or backfill should be stripped of all vegetation, organic material, and debris. Any existing undocumented or non-structural fill/backfill materials and other unsuitable materials should be excavated in their entirety. All areas that are to receive fill should be observed by TGE prior to placement of fill.

2. Fill should be compacted to 85% of the maximum density as compared to ASTM D 698 (standard Proctor) for the spoil pile and 90% for the sedimentation dikes/embankments.

3. Lift thickness for the sedimentation ponds should not exceed 12-inch loose lifts or 8-inch compacted lifts. Since large equipment will be used for the spoil pile, lifts can be as large as 4 feet. The lift thickness may be increased or decreased relative to the results of compaction test results during field verification as approved by TGE.

4. Saturated soils should be placed in an area that will have minimal effect on the performance of the slopes.

5. Native, undisturbed soils to serve as subgrade for the pond embankments should be scarified to a minimum depth of 12 inches, moisture conditioned to, or slightly above, optimum moisture content and re-compacted to at least 90% relative compaction.

6. A qualified geotechnical engineering firm under the direction of TGE, should observe the placement of fill and conduct in-place field density tests on the fill to check for adequate moisture content and relative compaction as outlined herein. If less than the specified relative compaction is obtained, additional compactive effort should be applied and the fill moisture-conditioned as necessary until the specified relative compaction is attained. The Contractor should provide level testing pads on which geotechnical engineering firm may conduct field density tests. The Contractor should provide safe and timely access for engineering personnel throughout the grading site to allow continued monitoring and testing.

7. Wherever, in the opinion of the Owner's representatives, an unstable condition is being created either by cutting or filling, the work should not proceed in that area until an evaluation has been made and the grading operations revised, if found necessary.

8. Fill should not be placed, spread or rolled during unfavorable weather conditions. When the work is interrupted by heavy rain or freezing temperatures, fill operations should not be resumed until field inspections indicate that the moisture content and density of the fill are as previously specified.

9. Whenever the words "supervision", "inspection", or "control" appear they should mean *observation* of the work and *testing* of the fill placement necessary by TGE or their representative to substantiate compliance with plans, specifications and design concepts.

Sediment Impoundment and Diversion Analysis

Replaces Appendix 5-2

The reconstruction of Lower Robinson Creek and modification of the road system in the facilities area has changed the watershed analysis associated with the impoundments and diversion ditches. Specifically, a Pond 1B was added to the facilities area to control runoff where the revised access road enters and exits the permit area. Also, diversion ditch 4 has been modified based on the reconstruction of Lower Robinson Creek.

This revised analysis replaces Appendix 5-2 and addresses the changes in the analysis. The changes in the document are as follows:

Impoundments

- Pond 1B (watershed 7) technical data is added to each one of the tables in the sediment impoundment section.
- A new Watershed 6 is added to the list of watersheds. This area is on the northwest side of the Lower Robinson Creek reconstruction.
- Impoundment 3 watershed has modified acreage and technical data which has been updated in the tables
- Minor text revisions updating references to the number of watersheds analyzed and methods for controlling sediment from impoundment Watersheds 5 and 6.

Diversion Ditches

- Diversion ditch 4 data is updated based on the revised design bordering the Lower Robinson Creek reconstruction.

APPENDIX 5-2

Sediment Impoundment and
Diversion Structure Analysis

By: Alton Coal Development, LLC
Chris McCourt, P.E.

CHRIS R.
MCCOURT
12-5-08
STATE OF UTAH

Coal Hollow Mine – Sedimentation Structure Sizing

Introduction

Protection of surface water quality at the Coal Hollow Mine is an important part of the mining process. By utilizing sedimentation structures for diversion and sediment impoundment, Alton Coal Development, LLC (ACD) will minimize the sediment that could potentially flow from active disturbance areas into drainages that are in and surrounding the proposed project area. Appropriate sizing of these structures is a necessary step toward ensuring that these controls function properly and serve the purpose of protecting the surrounding environment.

Therefore, ACD has completed a watershed analysis for appropriate sizing of five proposed sedimentation impoundments and four diversion ditches. This report will outline the methods used and results of this analysis.

Sediment Impoundments

Summary

The watersheds for the four proposed sedimentation impoundments have been evaluated mainly using the TR-55 method. This method of analysis was first issued by the Soil Conservation Service (SCS) in 1975. It has since been revised and updated numerous times. This method is applicable for evaluating small watersheds.

To assist with the calculations and mapping, Carlson 2007 Hydrology software has been utilized for this evaluation. A watershed analysis for this project includes: runoff flow paths, watershed boundaries, length and average grade for longest flow lines, runoff curve number classification, time of concentration and peak discharge. Information from this analysis was then used for sedimentation structure sizing. For the specifics associated with each of these parameters refer to the details section of this report.

The sedimentation structures were sized to impound the runoff associated with a 100-year frequency, 24-hour duration storm event. Using the Carlson rainfall map (assembled using TP-40 and TP-47 data), the rainfall intensity associated with this size of event for the Alton area is 3.1 inches. The following table summarizes the final results for each sedimentation structure:

Sedimentation Impoundment Capacities

Structure	Storage Required (ac/ft)	Design Storage* (ac/ft)	Percent of requirement	Additional Storage (ac/ft)
1	2.6	3.1	119	0.5
2	1.7	2.3	135	0.6
3	6.3	7.7	122	1.4
4	5.7	7.5	132	1.8
1B	0.5	0.8	160	0.3

*Design capacities include a minimum of 2 feet free board (spillway to top of embankment)

The enclosed maps and cross sections detail the design and location for each structure (Drawings 5-25 through 5-34). These drawings also show proposed spillways, diversion ditches and watersheds associated with each structure.

Details

Determining storage capacity requirements using the TR-55 method requires several steps. This section of the report will provide the details and assumptions associated with each step. These steps are: watershed boundaries/flow paths, runoff curve number classification, time of concentration, peak discharge and structure sizing.

- **Watershed Boundaries/Flow Paths**
  The watershed boundaries were determined by first identifying the runoff flow paths for the entire project area. This was completed by creating a three dimensional model of the surface topography. This model was then used to draw flow paths for all the watersheds. Based on these flow paths, boundaries for each watershed are easily determined based on flow direction in combination with proposed control structures (ponds, diversion ditches, etc..).

  Using this process, the project area (in conjunction with diversion ditch locations and berms) was found to be separated into seven distinct watersheds. The natural separations of watersheds in this area are Lower Robinson Creek to the north and Sink Valley Wash at the south end. In addition to these natural separations, the proposed diversion ditches and berms also provide definite boundaries as shown on Drawings 5-26 and 5-27. The following summarizes the watersheds:

Watersheds		
Watershed	**Area (acres)**	**Description**
1	27	North end of project area where facilities are proposed.
2	74	Borders south edge of Lower Robinson Creek.
3	285	Main watershed through the center of permit area
4	256	Southern most watershed bordered by Sink Valley Wash
*5	28	Isolated area between watersheds 3 and 4
*6	19	Area northwest of Lower Robinson Creek Reconstruction
7	5	Southwest end of facilities area, entrance/exit road

*These watersheds will have silt fence or other appropriate control measures installed.

- **Rainfall Amount and Runoff Curve Number Classification**
  First data required to begin estimating runoff for the watersheds is the rainfall amount and the runoff curve number classification. The rainfall amount is the precipitation associated with a 100 year frequency, 24 hour duration storm event. The runoff curve number classification is a classification of the soil and vegetation cover conditions for the watersheds.

  In order to estimate runoff from rainfall, the rainfall amount for a 100 year frequency, 24 hour duration storm event was determined using the Carlson rainfall map. This map was assembled by Carlson software based on TP-40 and TP-47 data. The resulting rainfall amount for the Alton area using this map is 3.1 inches.

The runoff curve number was determined by matching the ground cover description and estimated hydrologic soil group for the project area to the descriptions available in Table 2-2d of TR-55. Based on visual observations of the project area and soils the following classifications were estimated:

1. Cover Description: The cover description that best fits watersheds 2, 3 and 4 is "Sagebrush with grass understory". The hydrologic condition for this cover was estimated at "fair" which is defined as 30% to 70% ground cover. This estimation was based off the knowledge of current conditions and future disturbance/reclamation. Plans for this operation include sequenced disturbance combined with concurrent reclamation. This will minimize the area that will be disturbed at any one time. This will be combined with a general vegetation coverage improvement within one to two growing seasons for reclamation compared to current conditions. In addition, a significant amount of runoff from the active mining area for this magnitude of storm event will be temporarily controlled within the active pit area and will not immediately report to the designed impoundments.

   Watersheds 1 and 7 have been classified differently since they include the mine facilities area. These watersheds are classified as "Gravel roads" since most the area will be stripped of vegetation and gravel spread for parking areas and roads. This results in a much higher runoff than the classification for the other three watersheds.

2. Hydrologic Soil Group: This classification was estimated to be Group C for the five watersheds evaluated, as outlined in Appendix A in TR-55. This classification is for soils having low infiltration rates thus producing high amounts of runoff. The soils in this classification typically have infiltration rates of 0.05 to 0.15 inches per hour.

The resulting curve number for watersheds 2, 3 and 4 is 63. Watersheds 1 and 7 were assigned a curve number of 89. These classifications are intended to be conservative estimates (producing higher than expected runoff) to ensure that the sedimentation structures have more than sufficient storage capacity.

These classifications are used in the next step for determining the time of concentration.

- **Time of Concentration (T_c)**
  T_c is the time for runoff to travel from the furthest point in the watershed to the point that it meets the sedimentation structure. This figure is essential for calculating the peak flow which is used to determine the required size for the sedimentation structure. The SCS method for calculating T_c is used in this analysis. The following table summarizes the inputs for calculating the T_c along with the resulting outputs:

Time of Concentration (T_c)				
Watershed	Curve Number	Flow Length (ft)	Average Slope (%)	T_c (hrs)
1	89	1,087	6.8	0.16
2	63	5,670	3.8	1.7
3	63	7,095	3.5	2.2
4	63	6,831	2.9	2.3
7	89	750	3.6	0.08

  The T_c for each watershed is used to calculate the peak discharge which is the final step leading to the structure sizing.

- **Peak Discharge**
  The peak discharge for each watershed was calculated using the Graphical method. The inputs required for this method include: T_c, drainage area, 100 year 24 hour rainfall and the runoff curve number (CN). The following table outlines these inputs and the peak discharge:

Peak Discharge (*Inflow)					
Watershed	CN	Tc (hr)	Rainfall (in)	Drainage Area (ac)	Peak Discharge (cfs)
1	89	0.16	3.1	27	74.7
2	63	1.7	3.1	74	9.9
3	63	2.2	3.1	285	31.8
4	63	2.3	3.1	256	27.8
7	89	0.08	3.1	5	15.6

  *The peak discharge from each watershed will also be the peak inflow to the sedimentation structures.

- **Sedimentation Impoundment Sizing**
  The method used for this step is again from the TR-55 program. A sedimentation structure is required for each one of the five watersheds analyzed. Therefore, a size has been evaluated for the five proposed structures. The inputs for this calculation are the following: drainage area, peak inflow, desired outflow, and runoff depth (Q). The desired outflow in this situation is zero since we do not intend any discharge from the structures. The spillways for these structures are proposed for emergency use only and are not intended for regular discharges. The following table summarizes these inputs and the required storage capacity for each watershed:

Sedimentation Impoundment Sizing				
Structure	Drainage Area (ac)	Inflow (cfs)	Q (in)	Storage Required (ac-ft)
1	27	74.7	2.00	2.6
2	74	9.9	0.48	1.7
3	285	31.8	0.48	6.3
4	256	30.4	0.48	5.7
1B	5	15.6	2.00	0.5

The enclosed maps show the proposed design and locations for each one these structures.

Conclusions

This analysis provides estimates of sufficient storage capacities for each watershed analyzed to impound water from a 100 year frequency, 24 hour duration storm event at the proposed Coal Hollow Mine. In addition to the required storage capacities, a minimum 15% additional storage capacity has been added to each structure design to account for sediment and any standing water that may occur. Spillways have also been included in the structure designs to provide a non destructive route for discharge should these capacities ever be exceeded.

Due to the isolated characteristics and the inability to effectively divert water from Watersheds 5 and 6 , the method of using silt fence or other appropriate control measures for sediment have been chosen and are included on Drawing 5-26.

The structure designs established from this analysis will minimize impacts from sediment to the surrounding environment at the Coal Hollow Mine.

Diversion Ditches

Summary

The channel sizing for the four proposed diversion ditches has been evaluated using the TR-55 method to determine peak flows and the Manning's Equation (ME) to determine appropriate dimensions. The TR-55 method of analysis is the same method used to size impoundments and was utilized in this case to provide a peak flow for each diversion during a 100 year, 24 hour storm event. This peak flow was then input into the ME to determine an appropriate open channel design for minimizing the effects of erosion during peak flows. Similar to the impoundment sizing, the Carlson Software Hydrology module was utilized to perform these calculations. The ditch locations, designs and cross sections can be viewed on Drawings 5-33 and 5-34.

The following table summarizes the inputs and results for each diversion based on flows during a 100 year, 24 hour storm event:

Diversion Ditch Summary							
Ditch	*Base (ft)	Manning's n	Average Slope (%)	Peak Flow (cfs)	Flow Depth (ft)	Velocity (fps)	Freeboard (ft)
1	3.0	0.020	2.8	14.8	0.5	6.8	0.3
2	2.5	0.020	3.5	6.9	0.4	6.0	0.3
3	4.5	0.020	2.4	16.7	0.5	6.3	0.3
4	5.0	0.020	1.8	19.8	0.6	5.4	0.3

*All side slopes are 2h:1v

Details

- **Watersheds**
  The first step used for evaluating the diversions was to determine the peak flow during a 100 year, 24 hour storm event for each diversion. In order to determine this variable, the TR-55 method of watershed analysis was again utilized. This requires determining the watershed boundaries associated with each diversion. The following table summarizes these watersheds:

Diversion Watersheds		
Ditch	**Area (acres)**	**Description**
1	158	Diverts water outside project area into Pond 4
2	48	Diverts water along Robinson Creek to Pond 2
3	72	Diverts water around facilities area
4	169	Diverts water from project area into Pond 3

- **Rainfall Amount and Runoff Curve Number Classification**
  The rainfall amount for a 100 year, 24 hour storm event was developed utilizing the same method as previously discussed in the impoundments section of this report. This number is 3.1 inches of precipitation.

  The runoff curve number classification for all four watersheds was estimated to be 63. This classification is consistent with the classification and logic used for the impoundment analysis.

- **Time of Concentration (T_c)**
  T_c is the time for runoff to travel from the furthest point in the watershed to the point that it meets the sedimentation structure. This figure is essential for calculating the peak flow which is used to determine the required size for the diversion ditch. The SCS method for calculating T_c is used in this analysis. The following table summarizes the inputs for calculating the T_c along with the resulting outputs:

Time of Concentration (T_c)				
Ditch	Curve Number	Flow Length (ft)	Average Slope (%)	T_c (hrs)
1	63	8,487	2.9	2.9
2	63	4,187	3.6	1.4
3	63	3,742	13.7	0.7
4	63	5,868	3.9	1.8

The T_c for each watershed is used to calculate the peak flow which is the final step leading to the diversion dimensions.

- **Peak Flow**
  The peak flow for each diversion was calculated using the Graphical method. The inputs required for this method include: T_c, drainage area, 100 year 24 hour rainfall and the runoff curve number (CN). The following table outlines these inputs and the peak flow:

Diversion Peak Flow					
Ditch	CN	Tc (hr)	Rainfall (in)	Drainage Area (ac)	Peak Flow (cfs)
1	63	2.9	3.1	158	14.8
2	63	1.4	3.1	48	6.9
3	63	0.7	3.1	72	16.7
4	63	1.8	3.1	169	19.8

- **Diversion Dimensions**
  The Manning's Equation (ME) equation was used to appropriately size the each diversion. Inputs into this equation are manning's coefficient, average diversion slope, peak flow and side slope angles. Outputs are the depth of flow, and base dimension for a trapezoidal channel design. The following table summarizes the inputs and results:

Diversion Ditch Summary							
Ditch	**Base (ft)	*Manning n	Average Slope (%)	Peak Flow (cfs)	Flow Depth (ft)	Velocity (fps)	Freeboard (ft)
1	3.0	0.020	2.8	14.8	0.5	6.8	0.3
2	2.5	0.020	3.5	6.9	0.4	6.0	0.3
3	4.5	0.020	2.4	16.7	0.5	6.3	0.3
4	5.0	0.020	1.8	19.8	0.6	5.4	0.3

*Manning n of 0.020 is for ordinary firm loam

**All side slopes are 2h:1v

Conclusions

These diversions have been sized in manner that will transport the necessary flows and minimize erosion during a 100 year, 24 hour storm event. These diversions will prevent runoff from up gradient watersheds from entering the active mining areas and will also assist in directing water from disturbed areas to the sediment impoundments.

Coal Hollow Mine Blasting Plan

Appendix 5-4 is added to the Appendix Section of Chapter 5, Volume 3.

Though blasting is not expected at the Coal Hollow Mine, this Chapter 5 appendix is provided to address the requirement as outlined in R645-301-524. This plan is submitted as a contingency should blasting become necessary.

APPENDIX 5-4

Coal Hollow Mine Blasting Plan

By: Chris McCourt, P.E., Alton Coal Development, LLC
with assistance from Tom Campbell, TerraTek, LLC

REGISTERED PROFESSIONAL ENGINEER
275875-2202
CHRIS R.
MCCOURT
12-20-08
STATE OF UTAH

Alton Coal Development, LLC
Coal Hollow Mine
Blasting Plan

1. Introduction and General Information

The intent of this plan is to provide a summary of blasting operations should these operations become necessary at the Coal Hollow Mine. Based on current knowledge of the geologic formation planned for excavation and the methods for removal of overburden, it is expected that blasting will not be necessary. In the case that a geologic anomaly or unexpected conditions are experienced which require blasting; the following plan will apply:

Blasting operations and use of explosives at the Coal Hollow Mine will be conducted in accordance with the following:

- MSHA – Parts 56 and 57 Subpart E-Explosives
- Utah Administrative Code – R645-301-524
- Coal Hollow Mine Specifications
- Federal, State and local regulations governing the use of explosives

Blasting operations will be contracted to a competent and qualified organization with expertise in this area. This contractor will be required to have all necessary certifications and must follow this blasting plan along with all safety and environmental regulations that apply to the Coal Hollow Mine. This organization will be referred to as the "Contractor" for the purposes of this plan.

1.A. Explosives Handling

All explosives will be handled by a competent, qualified blaster and/or blasting foreman. This blaster and/or foreman will have proper certification as specified in Utah Administrative Code R645-301-524 and MSHA. The blasting foreman and the blaster will be knowledgeable of state, federal and local laws pertaining to explosives. In addition, they will be knowledgeable of the project specifications and the above referenced Documents in Section 1. The blaster may allow other persons to handle explosives only under his/her direct supervision. Explosives will be handled in a safe manner. The Contractor will be responsible for this individual(s) as needed for conducting blasting.

1.B. Storage of Explosives

Storage of explosives is not expected to occur at the Coal Hollow Mine. All explosives and the associated products necessary for blasting will be transported to the site by the Contractor on an as needed basis only. These products will be utilized for blasting in a timely manner and will not be stored for later use within the permit area of the Coal Hollow Mine. The Contractor will be responsible for removal of all explosives and blasting related products from the premise following each individual blast operation.

1.C. Transportation of Explosives

Explosives will be transported to the Coal Hollow Mine by the Contractor. Once at the mine, explosives will then be transported and handled by or under the direct supervision of the competent, qualified blaster and/or blasting foreman employed by the Contractor. Under all circumstances, jobsite transportation will comply with MSHA surface transportation of explosives requirements.

1.D. Use of Explosives

Explosives will be used only by a competent, qualified blaster or helper(s) under the direct supervision of the blaster and/or the blasting foreman. This blaster and/or foreman will have proper certification as specified in Utah Administrative Code R645-301-524 and MSHA.

When explosive materials are at the blast site, the blast site will be attended; barricaded and posted with warning signs, such as "Danger", "Explosives" or "Keep Out" or flagged against unauthorized entry.

Vehicles and equipment shall not be driven over the explosive material or initiating system.

1.D.1 Loading

Once loading begins the only activities permitted within the blasting site will be those activities directly related to the blasting operation and the activities of surveying, stemming, sampling of geology and reopening of holes, provided that reasonable care is exercised.

General specifications for loading of holes will be as follows:
The Blaster in charge will prime the booster with a delay cap, lower it into the hole, after reaching the bottom, the blaster will then have his assistant pour the explosive (anticipated to be ammonium nitrate with fuel oil (ANFO)) in the column to the predetermined height. Next, the laborer will stem the hole to the surface (collar) using gravel or cuttings from the drill hole. Alternative methods such as pre-splitting and use of emulsions may also be utilized when applicable.

Loading and blasting will be conducted in a manner designed to facilitate a continuous process, with the blast fired as soon as possible following completion of loading.

1.D.2 Firing and Inspection

Prior to blasting, all persons will be evacuated from the blasting zone and guards will be posted at the entrance of the blasting area. A typical blast sequence will be the following:

- 30 minute warning – Blast announced over all Coal Hollow Mine radio channels.
- 15 minute warning – Blast once again announced over all Coal Hollow Mine radio channels. Guards are placed at the entrance of the blasting area and the pit is cleared.
- 5 minute warning – Guards blocking all access, pit cleared, access to the blasting area blocked, radio silence required and siren activated. Siren will be three prolonged wales.
- 1 minute warning – A series of short siren wales
- Countdown to ignition @ 5,4,3,2,1 – Announced across Coal Hollow Mine radio channels
- All clear signal – One prolonged siren wale

A post blast inspection will be conducted by the qualified blaster and/or foreman prior to clearing the area. All guards will remain at their assigned positions until the blast area has been cleared by the qualified person.

The post blast inspection will include an examination of faces and/or muck piles associated with the blasting operation.

Darlynn Sorensen (Sorensen Ranch) and Richard Dame (Swapp Ranch) will be notified directly of this system and the meaning of the audible sirens.

1.D.3 Misfires

If a misfire occurs using electric or non-electric initiation systems, only work necessary to remove the misfire and protect safety of miners engaged in the removal will be permitted in the affected area. If a misfire can not be disposed of safely, each approach to the area affected by the misfire will be posted with a warning sign at a conspicuous location to prohibit entry, and the condition will be reported immediately to mine management.

1.E. Blast Warning Signs

Prior to commencement of blasting operations at the Coal Hollow Mine, signs will be placed at the locations where the currently existing County 136 intersects the permit boundary. Appropriate barricades will be in place at these two locations and signs will be added stating "Warning! Explosives in Use". These signs will also explain the blast warning signal system described in 1.D.2.

1.F. Blasting Schedule

If required, blasting will be scheduled Monday through Friday, between 1 P.M. and 4 P.M.. Blasting Operations will not be scheduled on Saturday, Sunday or at night.

At least ten days but not more than 30 days, prior to commencement of blasting operations, the blasting schedule for the Coal Hollow Mine will be published in the Southern Utah News, which is a newspaper of general circulation for the area.

In addition, copies of the blasting schedule will be provided to the Town of Alton, Kane County, Kanab Field Office BLM, Darlynn Sorensen (Sorensen Ranch) and Richard Dame (Swapp Ranch).

This schedule will be republished at least every 12 months and at any time when the schedule changes significantly from previous notifications. In the case of changes to the schedule, this publication will take place at least ten days but not more than 30 days prior to implementing the schedule change.

1G. Additional Precautions

During electrical storms, surface blasting operations will be suspended and persons withdrawn from the blast area to a safe location.

Smoking and use of open flames will not be permitted within 50 feet of explosive material. While working directly with explosives, personnel will not be allowed to have any matches, lighters or ignition sources on their person.

1H. Blast Design

The anticipated blast design can not be reasonably estimated at this time since Alton Coal Development, LLC (ACD) is not sure what local geologic conditions exist that may require blasting. If conditions are encountered that require blasting, ACD will provide the Division with the designed pattern prior to conducting blasting.

2. Pre- Blast Survey

Two Ranch properties exist within ½ mile of the proposed mining area that experience part time occupation by the owners. The properties are the Sorensen Ranch and the Swapp Ranches. Pre-blast surveys will be conducted of all the structures at these properties prior to conducting blasting operations. These structures with a brief description are provided on Drawings 1-5 and 1-6 in the MRP, Chapter 1, Volume 1. An Alton Coal Development, LLC representative will meet with the owners of these properties and conduct an inspection of each structure in cooperation with the owners. The conditions of each structure will be documented in a report both written and photographically. This report will be provided immediately to the Division following completion.

There are no other known structures or dwellings within a ½ mile of the planned operations.

3. Ground Vibration, Air Blast and Monitoring

Ground vibration and air blast will be minimized by utilizing proper blast pattern design techniques. By applying appropriate delays, powder factors and blast hole spacing these items can be minimized to comply with the required standards at the dwellings located at the Sorenson and Swapp Ranches. The following standards will be met at the Ranch structure locations:

Air Blast

Lower Frequency Limit of Measuring System, HZ (+3dB)		Maximum Level dB
0.1 Hz or lower – flat response		134 peak
2 Hz or lower – flat response		133 peak
6 Hz or lower – flat response		129 peak
C-weighed – slow response		105 peak dBC

Maximum Peak Particle Velocity (Ground Vibration)

Distance (D) from Blast Site in feet	Maximum allowable Particle Velocity (Vmax) for ground vibration, in inches/second (1)	Scaled distance factor to be applied without seismic monitoring (Ds) (2)
0 to 300	1.25	50
301 to 5,000	1.00	55
5,001 and beyond	0.75	65

(1) Ground Vibration will be measured as the particle velocity. Particle velocity will be recorded in three mutually perpendicular directions. The maximum allowable peak velocity will apply to each of the three measurements.

(2) Applicable in the scaled-diatance equation of Utah Code R645-301.524.651

Monitoring of air blast and ground vibration will be conducted at the Sorenson and Swapp Ranch occupied structures for the first two blasts conducted at the operation and any other blasts that take place within 1,000 feet of either of the occupied dwellings thereafter. This monitoring will be conducted using the following type of instrument and specifications:

- Thomas Instruments, Inc. blast monitoring seismograph VMS-2000 Series or equivalent. Sensitivity level for vibration is 0.02 in/s. Air blast is sensitive down to a trigger level of 100dB. This system records readings for both vibration and air blast once the trigger levels are exceeded. This recording is then loaded into software and reports can then be generated documenting the readings taken during the blast event.

This instrument will be setup on the ground near the foundation of the occupied dwellings on the side facing the blast operations. The resulting readings will be provided to the Division following each blast that is monitored.

4. Records of Blasting Operations

Records documenting blasting operations will be maintained at the mine site for at least three years and upon request will be made available to the Division upon request. These records will include all information as required in R645-301-524.700

Stability Evaluation/Analysis – Reclaimed Slopes

Appendix 5-5 is added to the Appendix Section of Chapter 5, Volume 3.

This appendix is submitted to address overall stability of reclaim slopes outside the excess spoil structure area.

APPENDIX 5-5

Stability Evaluation/Analysis – Reclaimed Slopes

By: Seegmiller International Mining Geotechnical Consultants/Engineers
Dr. Ben L. Seegmiller

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STABILITY EVALUATION/ANALYSIS
RECLAIMED SLOPES
COAL HOLLOW PROJECT
Kane County, Utah

PREPARED FOR

ALTON COAL DEVELOPMENT, LLC
Cedar City, Utah

by

Dr. Ben L. Seegmiller
Principal Consultant

November 2008

PROFESSIONAL ENGINEER
119433-2202
BEN L.
SEEGMILLER
STATE OF UTAH

Approved: 11-14-08
Ben L. Seegmiller, P.E. 119433-2202
President, Seegmiller International

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INTRODUCTORY OVERVIEW

The evaluation and analysis of reclaimed slopes for the Coal Hollow Project, Kane County, Utah is the subject of this report. Mr. Chris R. McCourt, P.E., Manager, Alton Coal Development LLC (ALTON) requested the study.

Coal mining near Alton, Utah is in the process of being permitted by the State of Utah, Department of Oil, Gas and Mining (UDOGM). A portion of the permit application reviewed by UDOGM has resulted in the following reply[1] to ALTON:

> ***R645-301-553.130**, The Applicant must show that all reclaimed slopes (including those not associated with the excess spoil area) have a safety factor of 1.3 or greater and that the slope angles are less than the angle of repose. The Applicant includes safety factor calculations for the excess spoil areas but did not mention the safety factors in other areas. One way to address the issue is to identify the slopes that would have the lowest safety factors (longest slope and steepest slope) and show that they meet the minimum safety factor requirements.*

The purposes of this report are to address the stability issues cited by UDOGM and show that minimum safety factor requirements are met.

Toward that end, a geometric description of identified slopes, including longest slope and steepest slope with the lowest safety factor, is presented. Next, material properties are evaluated and then information on groundwater is described. A slope stability analysis follows. The report concludes that a dry slope has a safety factor of 2.883 and a saturated slope has a safety factor of 1.722. The reclaimed slope angle is 18.4°, which is significantly less than the general area angle of repose of 33°-35°.

GEOTECHNICAL CHARACTERISTICS

Reclaimed Slopes/Slope Angles

The reclaimed slopes are planned[2] to have maximum slope angles of 3:1 (18.4°). The highest of these slopes, with the exception of the excess spoil slope, is planned[2] to be approximately 20 feet in vertical extent.

Material Properties

The composition of the reclaimed slopes will be Tropic Shale, which is a mixture of sandstone, siltstone and claystone, as well as finer and weaker alluvial soils. These slopes are assumed to have approximately the same material properties as the excess spoil, but placed without any compaction. Work done in earlier investigations[3] indicates that such materials may have friction angles on the order of 24° and cohesions of about 245 psf. Work over the past 18-20 years by SEEGMILLER in Wyoming suggests that similar uncompacted spoil materials would have densities of 120 pcf, friction angles of 33°+ and cohesions of about 400 psf. Mine area angles of repose were noted, during a SEEGMILLER visit to the Coal Hollow Project site on 8 Aug. 2008, to be approximately 33°-35° minimum.

Groundwater

The reclaimed slopes should typically be dry, but on occasion could have some groundwater. Consequently, this evaluation will examine the effects of groundwater in these reclaimed slopes.

SLOPE STABILITY ANALYSIS

Methodology

Basic Concepts. The stability analysis method that will be employed is based on limiting equilibrium concepts. At limiting equilibrium, the forces tending to create stability are exactly in balance with the forces tending to cause slope failure and, therefore, a safety factor of 1.00 exists. Greater or lesser safety factors allow the relative degree of safety of a slope to be measured. The computer code used for rotational shear is MCSLOPE. This code was created using the very popular code PCSTABL5 developed[4] at Purdue University as a basis. The PCSTABL5 code is used by many state highway departments to evaluate soil slope stability. The MCSLOPE code calculates a deterministic safety factor [SF_d] and uses a Monte Carlo technique to estimate the probabilistic factor of safety [SF_p] and a probability of slope failure [P/F].

Stability Criteria. The magnitude of the selected safety criteria depends on many factors including the risk of failure, quality of input data, the person doing the analyses and applicable governmental statutes. For the reclaimed slopes the applicable statutes[1] stipulate that the minimum factor of safety must be 1.3 and the slope angle must be less than the angle of repose.

Reclaimed Slope Analyses

Dry Slope. A detailed analysis of stability has been conducted for 20-foot high slopes with a 3:1 (18.4°) slope angle. The results give a safety factor of 2.883, which is more than twice that required by statute.

Saturated Slope. Analysis of this same 20-foot high slope at 3:1 (18.4°), under saturated conditions, yields a safety factor of 1.722, which is much greater than the 1.3 safety factor required by statute.

Angle of Repose Comparison. The planned 3:1 (18.4°) slope is much less than the general area angle of repose, which is concluded to be 33°-35° minimum. In fact, the planned slope angle is at least 14° less than the angle of repose.

REFERENCES

1. Department of Oil, Gas and Mining, State of Utah.

2. McCourt, Chris R., 2008, Personal Communication.

3. Taylor, A. O., 2007, Slope Stability Analysis, Alton, Utah, TGE Project No. 307001, April 23.

4. Carpenter, J. R., 1985, STABL5 . . . *The Spencer Method of Slices* . . . Final Report, Purdue University.

Chapter 5 Drawings Revisions and Additions

All Chapter 5 Drawings are replaced with the following submittal. Each drawing is changed to show the current address of Alton Coal Development, LLC in the title block. The following is a listing of each Drawing in Chapter 5 with a brief description of the significant changes and/or edits associated with this submittal:

General

5-1	**Pre-mining Topography:** Contour interval changed to 5', legend changed to Permit Boundary.
5-2	**Disturbance Sequence:** Disturbance boundary is changed to reflect edits associated with facilities, legend changed to Permit Boundary.

Facilities (5-3 to 5-8C)

5-3	**Facilities and Structures Layout:** Facilities have been edited to a more detailed design specification that removes the reclaim tunnels under the coal stockpile and replaces them with an above ground reclaim feeder, new access road system design, revised excess spoil pile design, revised ditch 4, new Pond 1B and legend changed to Permit Boundary.
5-4	**Loadout Elevation View 1:** Facilities have been edited to a more detailed design specification that removes the reclaim tunnels under the coal stockpile and replaces them with an above ground reclaim feeder, new access road system design, Pond 1B
5-5	**Loadout/Stockpile Elevation View 2:** Same as 5-4.
5-6	**Office Elevation View:** Address Change
5-7	**Maintenance Shop Elevation View:** Address Change
5-8	**Wash Bay, Oil and Fuel Storage Elevation View:** Address Change
5-8A	**Wash Bay Equipment Layout:** Added to provide plumbing and system details
5-8B	**Facilities and Structural – Electrical:** Added to provide electrical system details.
5-8C	**Facilities and Structural – Water Plan:** Added to provide details about water system

Coal Recovery (5-9 to 5-14)

5-9	**Coal Extraction Overview:** Legend changed to Permit Boundary.
5-10	**Coal Removal Sequence:** Legend changed to Permit Boundary.
5-11	**Shallow Coal Recovery Cover Cross Section:** Address Change
5-12	**Deep Coal Recovery Cross Section: Analyzed:** Address Change
5-13	**Strip Ratio Isopach:** Legend changed to Permit Boundary.
5-14	**Coal Thickness Isopach:** Legend changed to Permit Boundary.

Overburden Handling (5-15 to 5-19)

5-15	**Overburden Isopach:** Legend changed to Permit Boundary.
5-16	**Overburden Removal Sequence:** Legend changed to Permit Boundary.
5-17	**Overburden Removal Stage 1:** Revised design of excess spoil pile, Legend changed to Permit Boundary.
5-18	**Overburden Removal Stage 2:** Revised design of excess spoil pile, Legend changed to Permit Boundary.
5-19	**Overburden Removal Stage 3:** Revised design of excess spoil pile, Legend changed to Permit Boundary.

Robinson Creek Temporary Diversion and Reconstruction (5-20 to 5-21)

5-20	**Robinson Creek Temporary Diversion Plan View:** Drawing revised to reflect temporary design, main change is rip-rap is only placed on bends in channel rather than full length and legend changed to Permit Boundary.
5-20A	**Robinson Creek Reconstruction Plan View:** Added to address reconstruction of channel.
5-21	**Robinson Creek Temporary Diversion Cross Sections/Detail:** Same as 5-20
5-21A	**Robinson Creek Reconstruction Design and Details:** Same as 5-20A

Transportation (5-22 to 5-24)

5-22	**Primary Mine Haul Roads Plan View:** legend changed to Permit Boundary, 5' contours, updated with revised ditch 4 and Pond 1B.
5-22A	**Primary Roadways – Facilities Roadways:** added to show details for the facilities road.
5-22B	**Primary Roadways – Facilities Roadways:** Same as 5-22A
5-22C	**Postmining Roadways – Roadway to Pugh Property:** Added to show postmining design of road.
5-22D	**Postmining Roadways – Roadway to Water Well:** Added to show postmining design of road.
5-22E	**Postmining Roadways – Route 136 Reconstruction Details:** Added to show postmining design of road.
5-22F	**Postmining Roadways – Route 136 Reconstruction Details:** Added to show postmining design of road.
5-22G	**Postmining Roadways – Route 136 Reconstruction Details:** Added to show postmining design of road.
5-23	**Primary Mine Haul Roads Cross Sections/Detail:** Address updated
5-24	**Ancillary Roads Typical Cross Section:** Address updated

Sedimentation Diversions/Impoundments (5-25 to 5-34)

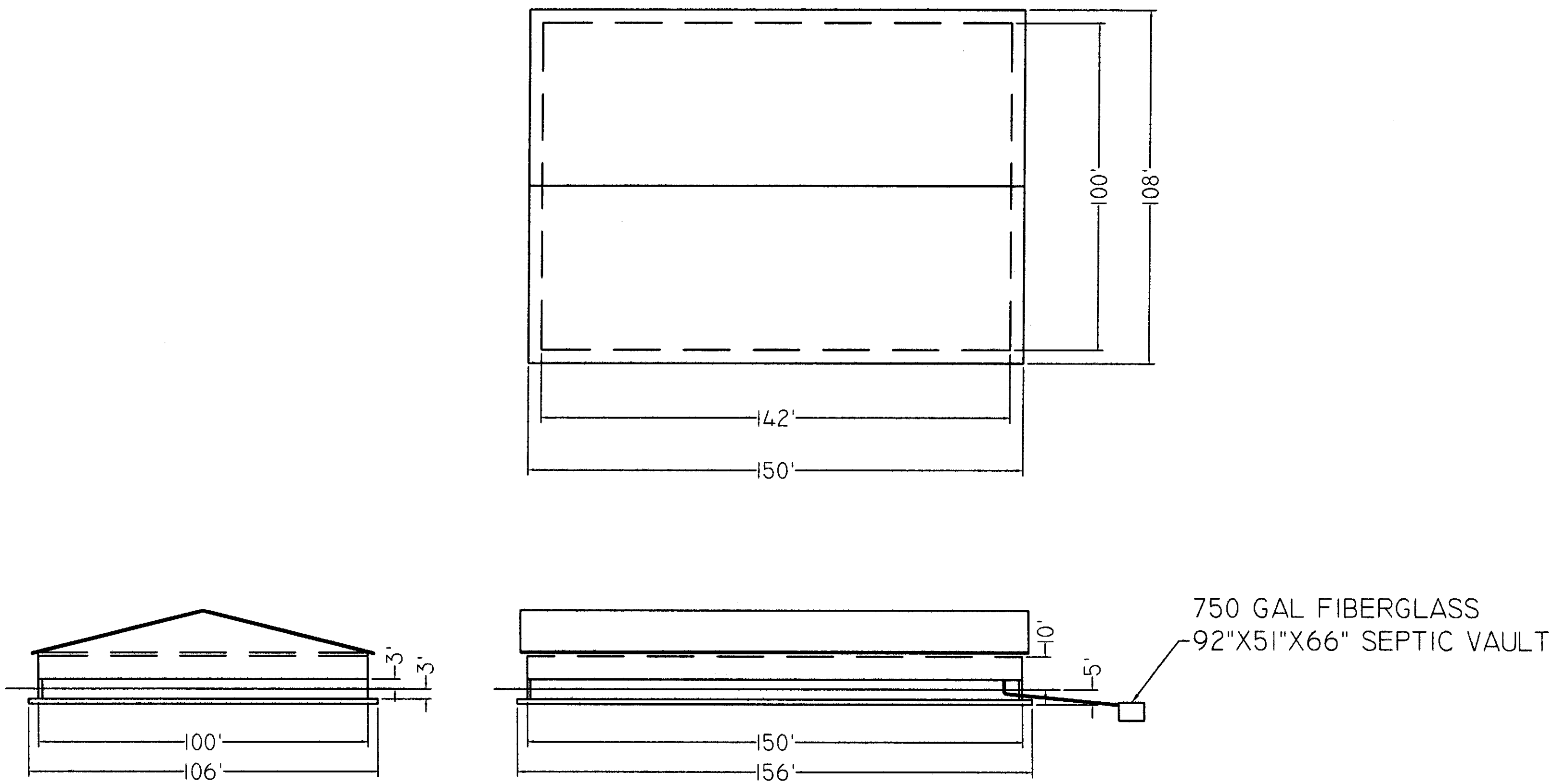
5-25	**Diversion Ditch and Sediment Impoundment Plan View:** Pond 1B is added, revised ditch 4, legend changed to Permit Boundary.
5-26	**Sediment Impoundment Watersheds:** Revision are made based on the reconstruction of Robinson Creek, Watershed 7 is added for Pond 1B, legend changed to Permit Boundary.
5-27	**Diversion Ditch Watersheds:** Revised ditch 4, legend changed to Permit Boundary.
5-28	**Sediment Impoundment 1 Details:** Address Change
5-28B	**Sediment Impoundment 1B Details:** Added to address a new pond that will contain water from the facilities road.
5-29	**Sediment Impoundment 2 Details:** Address Change
5-30	**Sediment Impoundment 3 Details:** Address Change
5-31	**Sediment Impoundment 4 Details:** Address Change
5-32	**Impoundment Spillway Detail:** Address Change
5-33	**Diversion Ditch 1 Details**: 5' contour interval, legend changed to Permit Boundary.
5-34	**Diversion Ditch 2, 3 and 4 Details:** Revised Ditch 4, 5' contour interval, legend changed to Permit Boundary.

Reclamation/Regrading (5-35 to 5-38)

5-35	**Post Mining Topography Preferred Scenario:** Revised design of excess spoil pile, 5' contour interval, postmining roads added, legend changed to Permit Boundary.
5-36	**Post Mining Topography Preferred Scenario Cross Sections:** Sections updated for 5' contours and revised excess spoil design.
5-37	**Post Mining Topography Alternate Scenario:** Revised design of excess spoil pile, 5' contour interval, postmining roads added, legend changed to Permit Boundary.
5-37A	**Post Mining Topography Alternate Scenario Cross Sections:** Same as 5-36.
5-38	**Reclamation Sequence:** Updated to show postmining roads, legend changed to Permit Boundary.

Geotechnical (5-39)

5-39	**Geotechnical Samples and Boring Locations:** legend changed to Permit Boundary.



OFFICE (150' X 100', 1 STORY)

NOTE: NOT DESIGNED FOR CONSTRUCTION, FOR BONDING PURPOSES ONLY.

DRAWN BY: L. JOHNSON G. GROSSMAN	CHECKED BY: CRM/WES	**OFFICE**	
DRAWING: 5–6	DATE: 11/10/08	COAL HOLLOW PROJECT ALTON, UTAH	
	SCALE: NTS		
JOB NUMBER: 1400	SHEET	**DRAWING: 5-6**	

Registered Professional Engineer 354279-2202 WILLIAM E. SPITZENBERG 12/08/08 State of Utah

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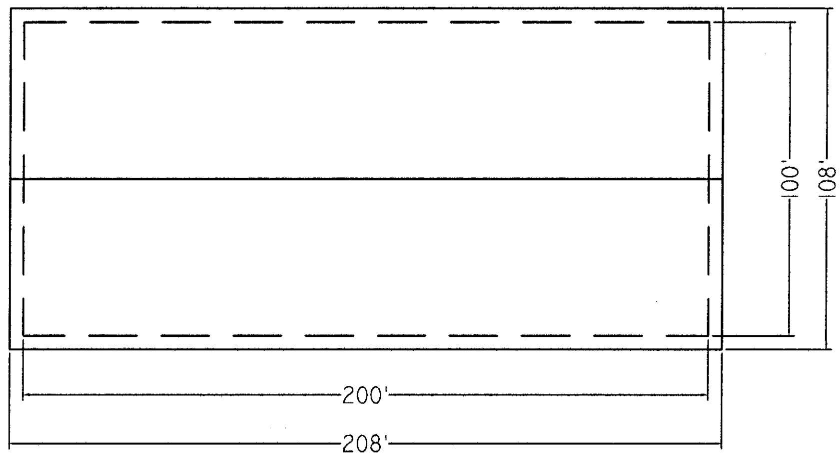

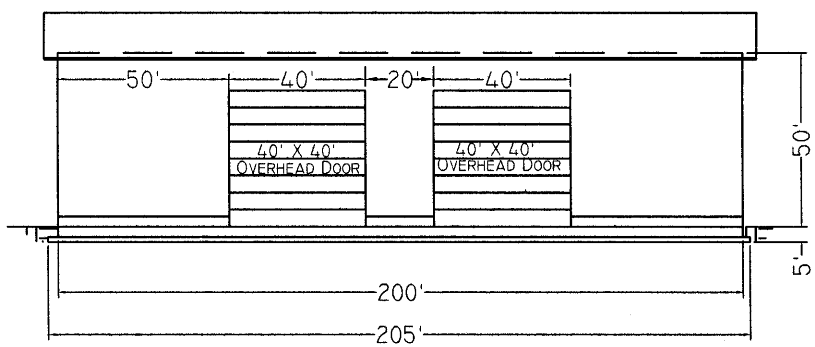

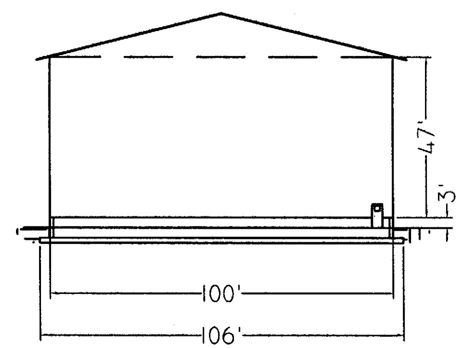

DRAWN BY: L. JOHNSON G. GROSSMAN	CHECKED BY: CRM/WES	MAINTENANCE SHOP COAL HOLLOW PROJECT ALTON, UTAH DRAWING: 5-7	Registered Professional Engineer 354279-2202 WILLIAM E. SPITZENBERG 12/08/08 State of Utah RECEIVED DEC 2 2 2008	Alton Coal Development Coal Hollow Project 463 North 100 West, Suite 1 Cedar City, Utah 84720 Phone (435) 867-5331 Fax (435) 867-1192
DRAWING: 5–7	DATE: 11/10/08 SCALE: NTS			
JOB NUMBER: 1400	SHEET			

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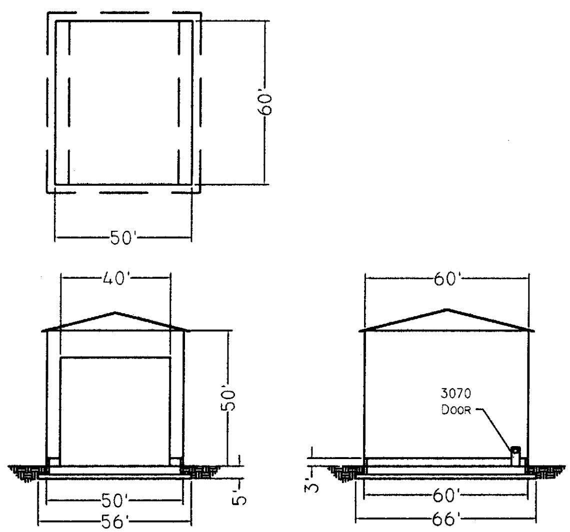
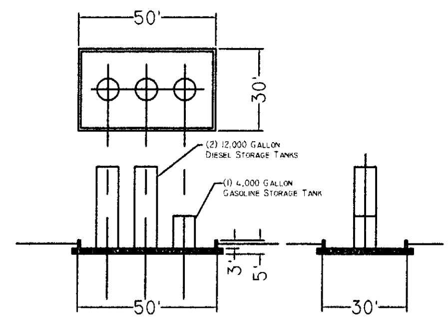
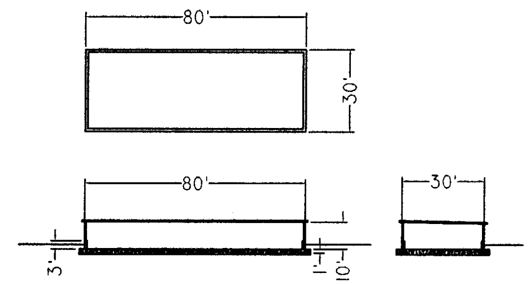


WASH BAY (50' X 60' X 50' HIGH)



28,000 GALLON FUEL STORAGE
50' LONG X 30' WIDE X 3' DEEP



50,000 GALLON OIL STORAGE
80' LONG X 30' WIDE X 3' DEEP

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DRAWN BY: L. JOHNSON G. GROSSMAN	CHECKED BY: CRM/WES	WASH BAY, OIL & FUEL STORAGE COAL HOLLOW PROJECT ALTON, UTAH DRAWING: 5-8	Registered Professional Engineer 354279-2202 WILLIAM E. SPITZENBERG 12/08/08 State of Utah
DRAWING: 5-8	DATE: 11/10/08		Alton Coal Development Coal Hollow Project 463 North 100 West Suite 1 Cedar City, Utah 84720 Phone (435) 867-5331 Fax (435) 867-1192
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RIESKAMP EQUIPMENT POWER REQUIREMENTS MDC		
QNTY.	DESCRIPTION	SPECIFICATIONS
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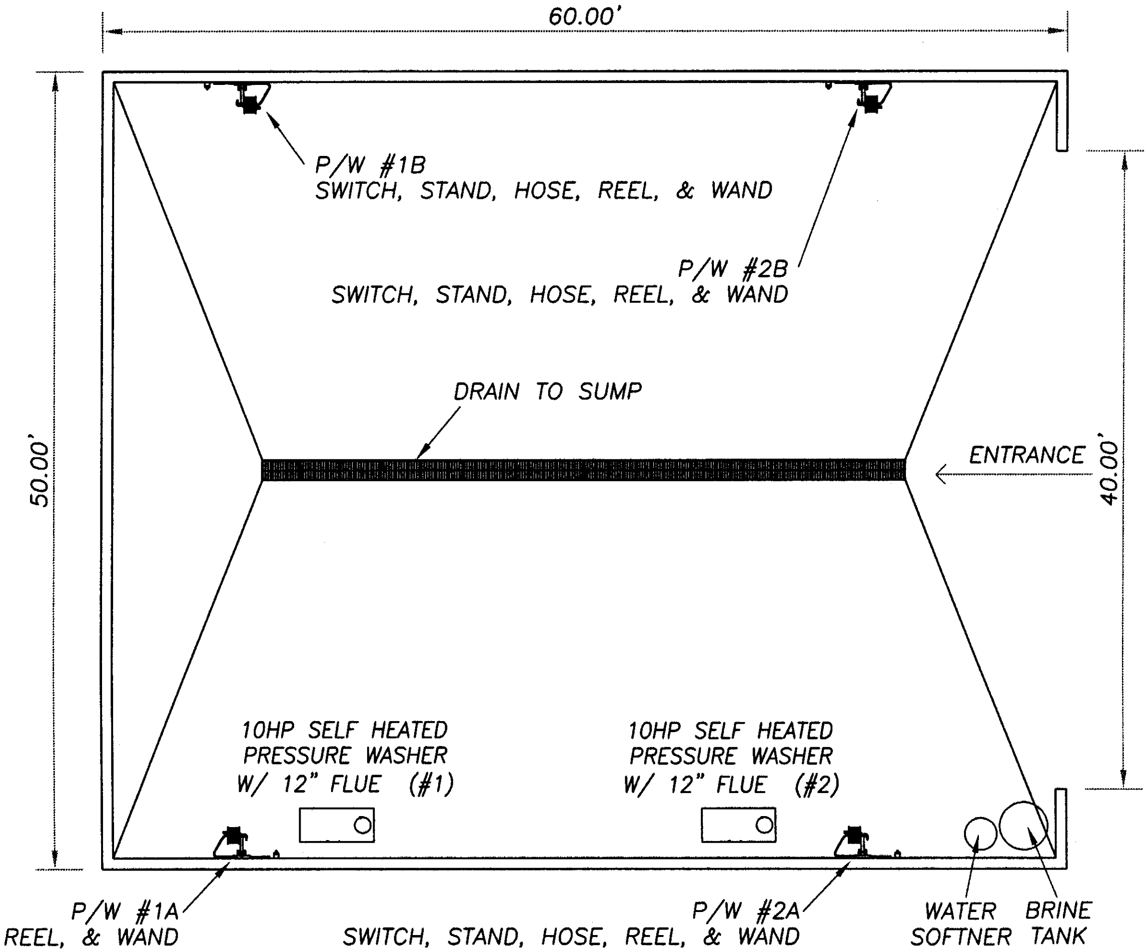
(1)	WATER SOFTNER	120V STANDARD OUTLET



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G. GROSSMAN	CRM/WES
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	SCALE:
	1"=1'
JOB NUMBER: 1400	SHEET

WASH BAY EQUIPMENT LAYOUT

COAL HOLLOW PROJECT
ALTON, UTAH

DRAWING: 5-8A

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Fax (435) 867-1192

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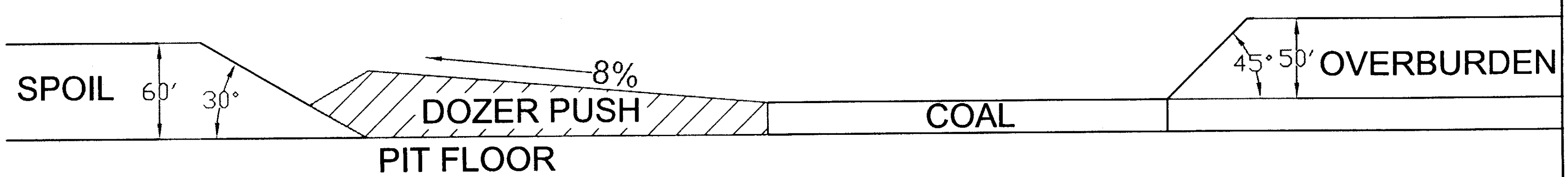

Note: This typical section assumes that the overburden is Tropic Shale.

DRAWN BY:	CHECKED BY:
C. McCourt	BLS
DRAWING: 5-11	DATE: 11/10/08
	SCALE: 1" = 100'
JOB NUMBER: 1400	SHEET

SHALLOW COVER TYPICAL CROSS SECTION

COAL HOLLOW PROJECT
ALTON, UTAH

DRAWING: 5-11

Registered Professional Engineer
119433-2202
Ben L. Seegmiller
11-10-08
State of Utah

Alton Coal Development
Coal Hollow Project

463 North 100 West, Suite 1
Cedar City, Utah 84720
Phone (435)867-5331
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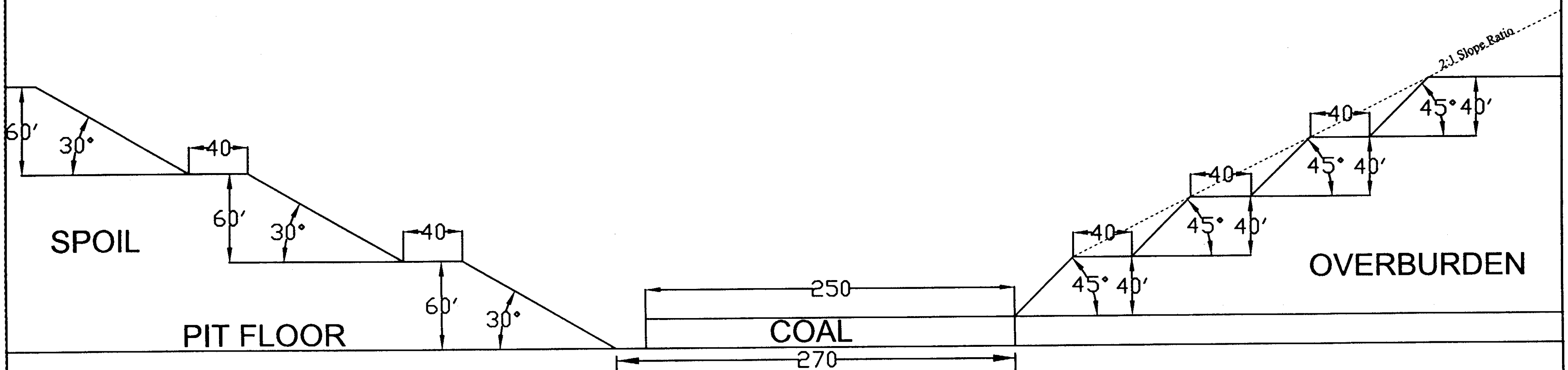

Note: This typical section assumes that the overburden is Tropic Shale.

DRAWN BY:	CHECKED BY:
C. McCourt	BLS
DRAWING: 5-12	DATE: 11/10/08
	SCALE: 1" = 100'
JOB NUMBER: 1400	SHEET

DEEP COVER
TYPICAL CROSS SECTION

COAL HOLLOW
PROJECT
ALTON, UTAH

DRAWING: 5-12

Registered Professional Engineer
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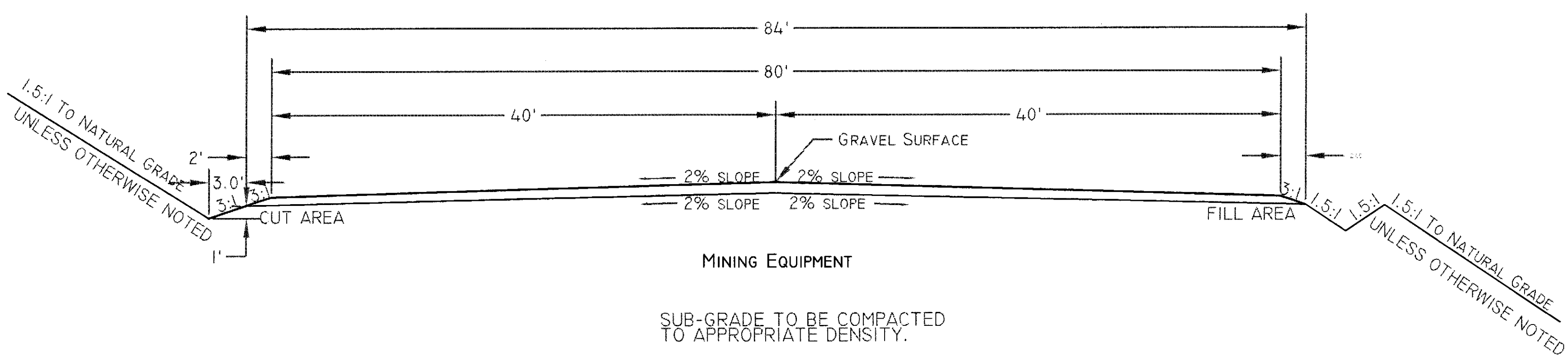
TYPICAL CROSS SECTION



MINING EQUIPMENT

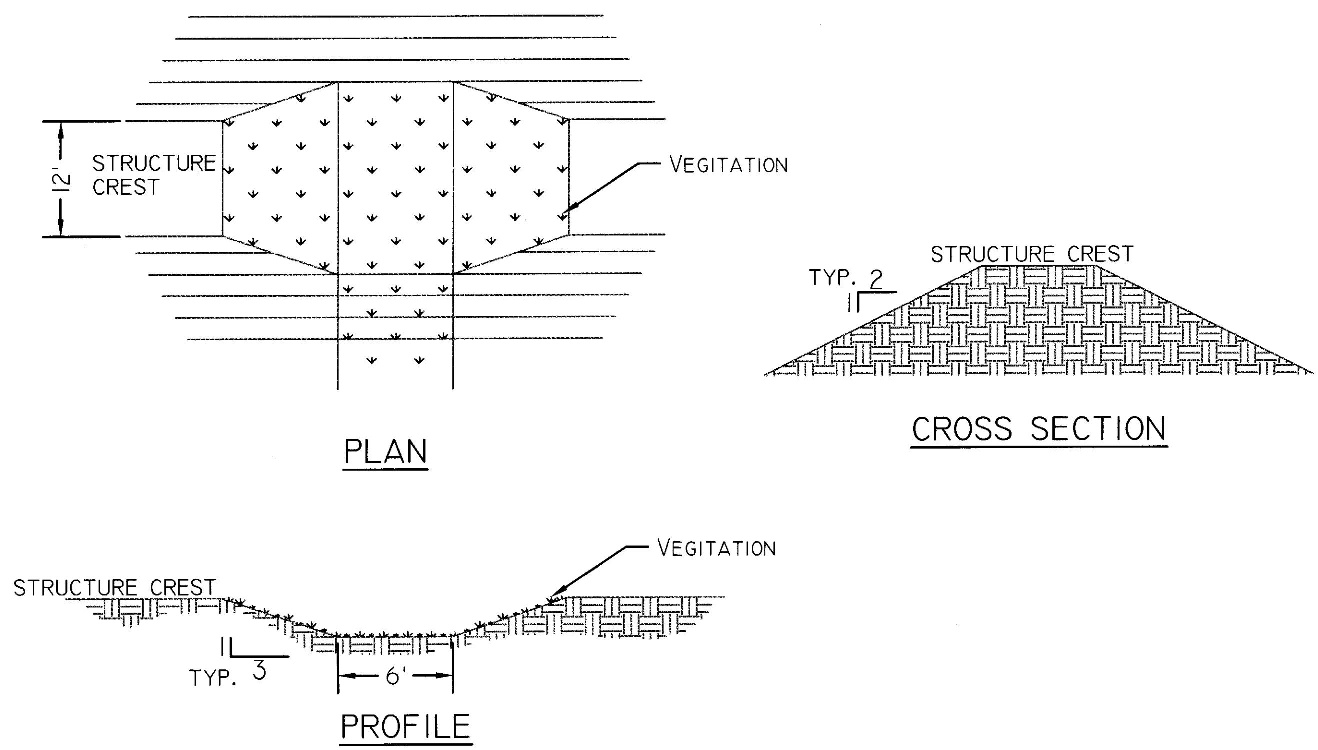
SUB-GRADE TO BE COMPACTED
TO APPROPRIATE DENSITY.

GRAVEL TO BE PLACED AS NEEDED.

ANCILLARY ROADS FOR LIGHT VEHICLES WILL BE
NARROWED TO 24' IN WIDTH.

DRAWN BY: C. McCOURT J. STANSFIELD	CHECKED BY: CRM	ANCILLARY ROADS TYPICAL CROSS SECTION COAL HOLLOW PROJECT ALTON, UTAH DRAWING: 5-24	Registered Professional Engineer 275875-2202 CHRIS R. McCOURT 12-14-08 State of Utah RECEIVED DEC 2 2 2008	Alton Coal Development Coal Hollow Project
DRAWING: 5–24	DATE: 04/20/07 MODIFIED 11/28/08			463 North 100 West, Suite 1 Cedar City, Utah 84720 Phone (435)867-5331 Fax (435)867-1192
	SCALE: NTS			
JOB NUMBER: 1400	SHEET			

DIV. OF OIL, GAS & MINING



DRAWN BY:	CHECKED BY:
J. STANSFIELD	CRM
DRAWING: 5-32	DATE: 4/20/07 Revised 12/4/08
	SCALE: 1" = 20'
JOB NUMBER: 1400	SHEET

IMPOUNDMENT SPILWAY DETAIL

COAL HOLLOW
PROJECT
ALTON, UTAH

DRAWING: 5-32

Registered Professional Engineer
275875-2202
CHRIS R. McCOURT
12-14-08
State of Utah

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Coal Hollow Project

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